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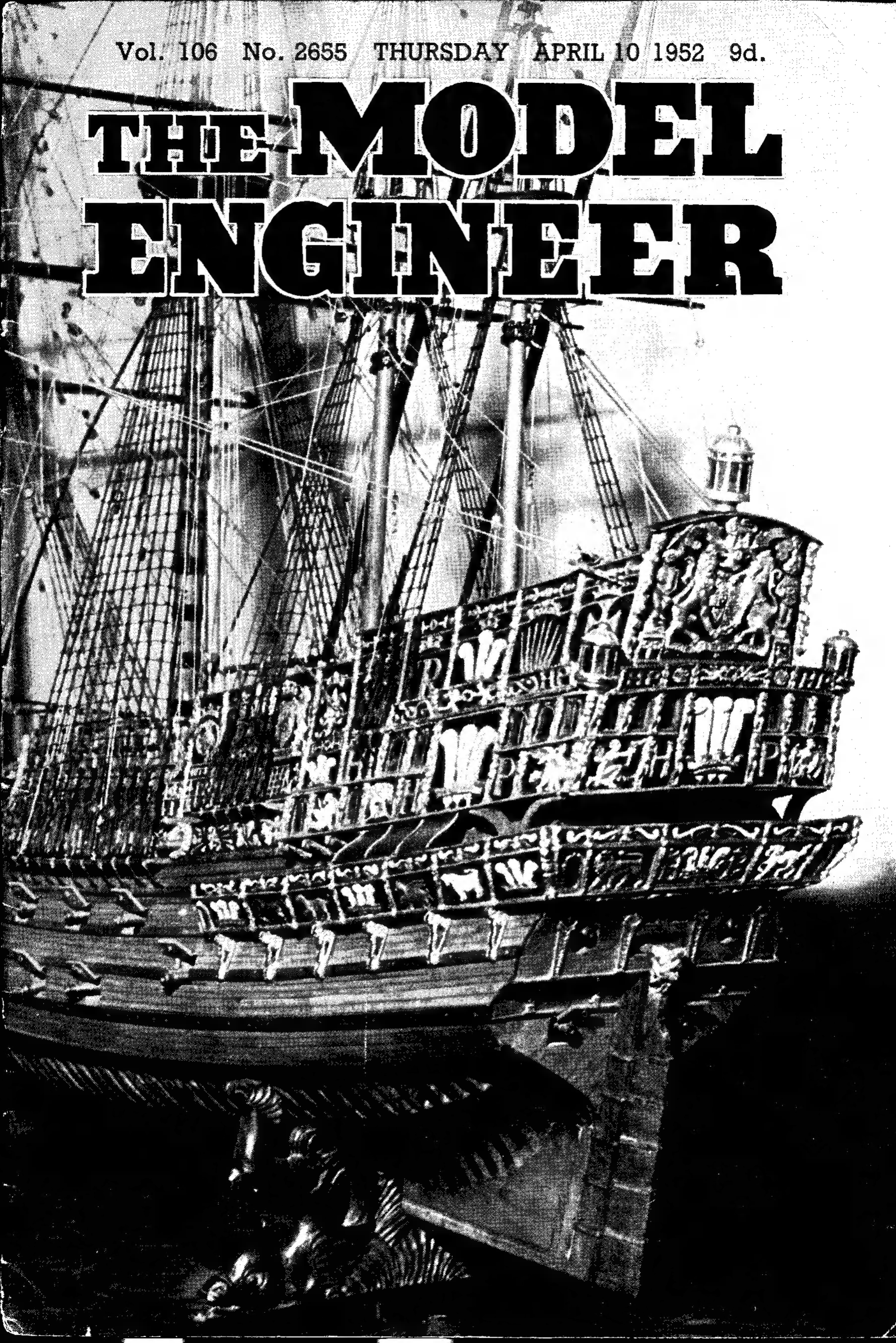
THE MODEL ENGINEER



The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

10TH APRIL 1952 VOL. 106 NO. 2655

SMOKE RINGS

Our Cover Picture

● THE COVER picture for the issue of December 27th of last year was the photograph of the model of the *Royal Prince*, built in 1610 during the reign of James I The model was made by Mr. Robert Spence, of Hampstead, who is well known for his models of historical ships. This week we use another photograph of the same model, this time to show the beautiful work involved in reproducing the elaborate decoration of the stern. Much of the decoration is carved on the framework of the ship, and to undertake the construction of a model such as this calls for careful preliminary planning. It is usually easier and more convenient to carve the ornament before fitting the part into its position in the model ; therefore, the builder must have the complete picture of the finished model in his mind before starting work. In this model, as is the case with ships generally, the basic beauty lies not so much in the decoration as in the form of the ship herself. As will be seen from the photograph, the model is built in Navy Board Fashion, with the underwater planking omitted. This emphasises the lovely curves of the hull under the quarters and right out to the transom stern. Even in those days, ship designers realised the importance of easy curves in the after part of the vessel, a feature which aero-nautical research has in these latter days proved so essential in high-speed aircraft. It would, therefore, appear that the full entrance and fine run of ships in those days, or the "cod's head and mackerel tail" as it was termed, was scientifically more correct than the designs which replaced them during the last century.

From One of the Craftsmen

● IN "SMOKE RINGS" for January 31st last, we published a photograph of a very interesting model of an oil refinery, another photograph of which appeared on the cover of the same issue. We have received a letter from Mr. Sam Leedham, one of the two craftsmen who were responsible for the construction of the model ; in acknowledging a letter which we had sent to him he writes : "It is the first model of this type I have attempted. I have always been interested in model engineering, more so in working models.

"I have had great help from THE MODEL ENGINEER, of which I have been a reader for about 40 years, and I always look forward to Thursday.

"I am now 65 years of age and am at present employed in making a model of the new jetty for the tankers in connection with the new refinery ; it is to the scale of 1/24 in. to 1 ft., and I am getting a lot of pleasure out of it. I am looking forward to the next MODEL ENGINEER Exhibition in London."

Mr. Leedham has our best wishes for many years of pleasure in his model making, and we hope that if he visits the "M.E." Exhibition, he will take the opportunity of making himself known to us personally. We are always glad to make the acquaintance of readers who have enjoyed THE MODEL ENGINEER for several decades.

The Split-single Two-stroke

● WE PUBLISH in this issue the first of a series of articles by Mr. R. E. Mitchell, on the construction of a very interesting engine which he has used with success in his well-known " C " class speed boat *Gamma*. This type of engine is one which is at present attracting considerable attention among designers, having been exploited in motor-cycle and automobile practice, particularly on the Continent, though contrary to general opinion, the earliest practical development of the principle was in this country. During the early years of this century, it was used in the " Valveless " car, and also in a racing car known as the " Lamplugh." For very many years, almost the sole representative of the type was the ingenious " Trojan " car, until it was taken up and developed to a high state of efficiency by such firms as Zoller, Puch, and D.K.W. Apart from the use of this principle by Mr. Mitchell, his ingenious application of it for driving twin screws in opposite directions, without the need of extraneous gearing, is of great interest. Mr. A. D. Rankine also used a split-single engine, in this case using a single crankshaft, in his boat *Oigh Alba Junior*, which came to an untimely end in a fire some years ago. Other model designers are, to our knowledge, making experiments with this principle, which offers promise of overcoming some of the inherent limitations of the ordinary two-stroke, not to mention introducing welcome variety into the design of these engines.

New Aid for the Inventor

● TO PARAPHRASE W. S. Gilbert, the inventor's lot, generally speaking, is " not a happy one." It is rather incongruous that in the age of progress, when new ideas, improved methods and greater speed of production are paramount essentials, the individuals on whom progress depends should have great difficulty in commercialising their inventions and reaping the reward of their labours. Sometimes, after spending half a lifetime in perfecting some new device, and spending hard-earned savings in patent fees, the inventor finds that his task, so far from being ended, is but hardly begun. He must spend yet more time and money in contacting possible markets, and convincing hard-headed but non-technical business men of the value of his invention. Small wonder is it then that only a very small percentage of inventions ever become a commercial success, and that their creators often finish up as disillusioned and embittered men.

We welcome, therefore, a new enterprise which has been formed in this country, with the laudable aim of helping inventors over their difficulties. Its sponsers offer a service whereby the inventor can, at a small cost, obtain impartial advice as to whether his ideas have a reasonable chance of success, and how that success can best be achieved. If the invention is a promising one and the inventor unable, by lack of finance and facilities, to protect and develop it, they may be able to arrange suitable backing. Having many contacts in finance and industry, both in this country and the Dominions, they hope to bridge the gap between the inventor and the producer, which has always been a serious obstacle to full industrial efficiency. Readers who are interested in this service should write to Approved Inventions Ltd., 7, Princes Street, Hanover Square, London, W.1.

An " M.E." Tie ?

● THE POSSIBILITY of producing a specially designed " M.E." tie, which was discussed some eighteen months ago, has again come under consideration, and one of our advertisers has expressed willingness to undertake the production and marketing of such a tie, with our co-operation. Personal investigation has led us to believe that this proposition would be more popular among readers than at first thought, as the tie would enable model engineers instantly to recognise kindred spirits and would be more readily identifiable than the many and diverse club badges which may be confused with those of other organisations. If the idea appeals to readers, we should be interested to hear from them, and also to have any practical suggestions for the design and colour scheme of the tie.

Steam Still in Vogue

● THAT THE marine steam engine is not yet the " back number " that some people would have us believe, is shown by the fact that the three tugboats ordered last January from Cochrane & Sons Ltd., Selby, by the Alexandra Towing Co. Ltd., Liverpool, will be powered by triple-expansion engines built by Charles D. Holmes & Co. Ltd., Hull. Last year, these owners took delivery from the same builders of the steam tugs *Canada*, *Formby* and *Gladstone*, which are also powered by Holmes-built triple-expansion engines. These three tugs replaced older ones bearing the same names.

This is refreshing news in these days, and we know that it will be warmly welcomed by all lovers of the steam engine. We imagine that one of the reasons for the apparent reversion to steam is desire to avoid the high cost of imported fuel.

No No !

● A WRITER in a recent issue of the *Railway Observer*, the bright little journal of the Railway Correspondence and Travel Society, predicts some rather horrible possibilities as a result of the present system of classifying electric locomotives ; he writes : " I deplore Bo Bo and Co Co ; the next step will be Do Do, and who knows, we may in the future run into Fi Fi and Ha Ha. As far as I am concerned I am prepared to let the whole thing Go Go ! "

He has our sympathy.

The Late Dr. H. W. Dickinson

● WE REGRET to learn of the death of Dr. H. W. Dickinson, which occurred during February. Dr. Dickinson, who was 81, was perhaps best known to many of our readers as one of the founder members of the Newcomen Society in 1920 ; he was its honorary secretary for many years. He was an authority on engineering history and the author of a number of valuable biographical studies of men like James Watt, Robert Fulton, Richard Trevithick and others. His passing is a severe loss to the study of the history of engineering and technology.

And Now, Steam-Wagons !

by W. Boddy

FIVE years ago I had the happy idea of hunting traction-engines with car and camera. I was allowed to describe the results in THE MODEL ENGINEER of July 31st, 1947, and to enlarge on the subject in the issue for May 6th, 1948. I hope I shall not be deemed immodest if I claim that these articles "started something." Certainly a lot of interesting correspondence came to hand and since then that extremely interesting book, *Traction Engines Worth Modelling*, by W. J. Hughes, has been published. All of which gives rise to the thought that whereas, when I commenced my hunt, *any* traction-engine was an exciting find, today those that lie derelict in yards and fields are of less appeal than the engines which are still faithfully serving their showmen or farmer owners. Happily, quite a number of traction-engines is still in use and as one who is by no means an expert I feel that they can now be safely left to the attention of Mr. Hughes and members of the Road Locomotive Society.

Last active steamer in London ? Camroux' Foden, of circa 1928

But I find myself wondering, what of the almost equally-fascinating steam-wagon ? This class of steamer seems in much greater danger of joining the dodo than does the traction-engine and road locomotive.

Indeed, quite by chance recently, I came upon what I think may well be the last steam-wagon of its kind still licensed and in harness in London. It was standing, when I first encountered it, on the weighbridge at Shepherd's Bush goods-yard, sooty smoke curling from its chimney. I hadn't a camera with me on that occasion but I returned with one the next day and sure enough a wisp of steam at the far end of the line of railway trucks showed that this exciting discovery had not eluded me. The weather was very overcast, however, so I made but one exposure, for which driver and his mate obligingly stood in a most professional pose beside their vehicle. A few days later, I tried some more pictures, using to good purpose the brisk acceleration of the Morgan Plus Four I was driving to overtake the wagon, which was on its way out just as I arrived.

It is a short-wheelbase Foden 6-tonner of about 1928, its number, which it displays on its patents-plate on the off-side being 13196. It is owned by Camroux, the coal merchants, who acquired it second-hand. Its present task is that of pulling a four-wheeled truck containing 10-11 tons of coal from the aforesaid yard to Hammersmith Hospital, an out-and-home run of about three miles. This it accomplishes with ease, fully up to its speed-limit of 10 m.p.h., the exhaust beat very healthy as it accelerates or tackles a rise. I was delighted to see that this Foden was greeted with waves and flashing of headlamps by drivers of mere i.c. lorries proceeding into London down Wood Lane. Less pleased was a road-sweeper, who complained that coal was being scattered over his newly-swept gutters, which at least proved that the Foden was capable of pulling the biggest load that its truck would take !

I have no doubt that, having described this nostalgic sight with a view to arousing steam-wagon sympathies, the purists will tell me that this particular Foden isn't a wagon at all, but is, in fact, a tractor. Agreed it has no platform aft of its cab, but instead a curving tail on which is clipped a trolley for the transportation of coal bags. Perhaps it *is* a tractor but to me it recalls the steam-wagons which used to diffuse their pleasant odour of oily heat amongst the petrol fumes of the middle-twenties. If such wagons shared much of their fascination with the more unwieldy traction-engines, they had the distinction of having to operate amongst the congestion of city streets and to compete with the petrol lorry as they moved their loads of beer barrels, cement, machine-tools and what-have-you.

Imagine yourself transport manager to a large firm in the year, let us say, 1924. You have to increase your transport fleet. Shall the newcomers be steamers or petrol lorries? That must depend on what journeys your vehicles undertake and whether you have access to your own supplies of coal. If the coal or coke is there and if the hauls are comparatively short ones, such as two runs per day of ten miles each or a delivery thirty miles or so one day, returning the next day, and if a mate has to be carried in any case, you may well consider the steamer for your heavy loads.

And what a difficult choice you would have to make! For example, Foden can offer you their standard six-tonner overtype compound, able to shift its load at up to 12 m.p.h. and up a 1 in 7 hill, and to haul four more tons on a trailer. It will provide a platform space of 14 ft. × 6 ft. 6 in. and its Siemens loco.-type boiler has a safe working pressure of 220 lb. sq. in. The 4¼ in. and 7 in. × 7 in. cylinders are supplied with steam generated by a firebox having a total heating surface of 90 sq. ft. The under-chassis water-tank holds about 137 gallons, sufficient for 30 miles on good roads (or 20 miles at worst) with full load, and the fuel bunker holds enough coal or coke for 40 miles. Boiler feed is by pump and injector. You can specify two speeds, giving 6 and 12 m.p.h., or have an additional speed in which the Foden will reach 16 m.p.h. running light. An attractive and well-tried wagon.

You may, however, decide to travel to Ipswich to inspect the latest Ransome overtype. The salesman will indicate the arrangement of a flywheel on each side of the two-throw crankshaft so that the driver has a decent chance of seeing the road ahead, which other overtypes cannot boast. He will also show you how the regulator-valve lever is situated in the centre of the foot-plate so that it can be swung over for operation by either driver or stoker, as required. He is certain to tell you of the merits of the Ransome stayless boiler, working at 225 lb. sq. in., the four-piece circular construction of which obviates the possibility of broken or leaking stays, suffers less from dirty water, and is easy to clean.

This Ransome wagon has 4¼ in. and 7¼ in. × 8 in. compound cylinders, a water tank capacity of 150 gallons and carries 4 cwt. of fuel in its under-cab bunker. The cab awning gives generous protection. The total heating surface is 75 sq. ft., the feed pump is driven by a geared down eccentric, and there is an injector. The wheelbase is 12 ft. 7 in. and the overall length 21 ft. 9 in.

If your mind is still not made up I can imagine you going to Leeds for a demonstration of the Mann overtype, one of the pioneers. They will show you two models, a five-tonner that can haul three tons on a trailer and a three-tonner able to tow two extra tons. You will, I expect, remark the short loco.-type boiler, of which it is claimed that the tubes are less likely to become uncovered uphill, or the firebox going downhill, and the location of the fuel bunker so that the driver can do the firing himself if needs be.

Then you may be interested in the Garrett. This wagon has a patent corrugated-type firebox, for which 50 per cent. more heating surface is claimed at the top of the box. A superheater is fitted as standard to the three-ton overtype and as an extra on the five-tonner. I feel that, even though you are so thorough that you insist on seeing all the available makes before ordering, the Editor will not desire me to accompany you further, so I will leave you at Lincoln, looking at the Clayton standard five-tonner, the 4½-5 cwt. bunker of which suffices for a 50-mile haul, the water tank carrying 150 gallons. A three-ton trailer can be pulled, up gradients of as much as 1 in 6, and they will tell you that on rubber tyres your Clayton should cover 75,000 ton-miles a year at 2½d. per ton-mile.

All these overtypes have in common a compound engine, with provision for admitting high-pressure steam to both cylinders in emergencies, Ackermann steering, final drive by a long 2½ in. pitch chain and differential gear, and brakes on the back wheels; unless you are buying a second-hand model, when there may be a flywheel brake also, and perhaps a swivelling front axle. The Clayton you are gazing at has 4 and 7¼ in. × 7 in. cylinders, but a smaller 3-4 tonner has 3¾ and 6¾ in. × 6 in. cylinders.

An overtype will probably be your choice if your men are accustomed to loco-type boilers, if the absolute maximum of platform space is not essential, and if you operate more along main roads than in traffic where the impaired visibility will be noticeable to the driver.

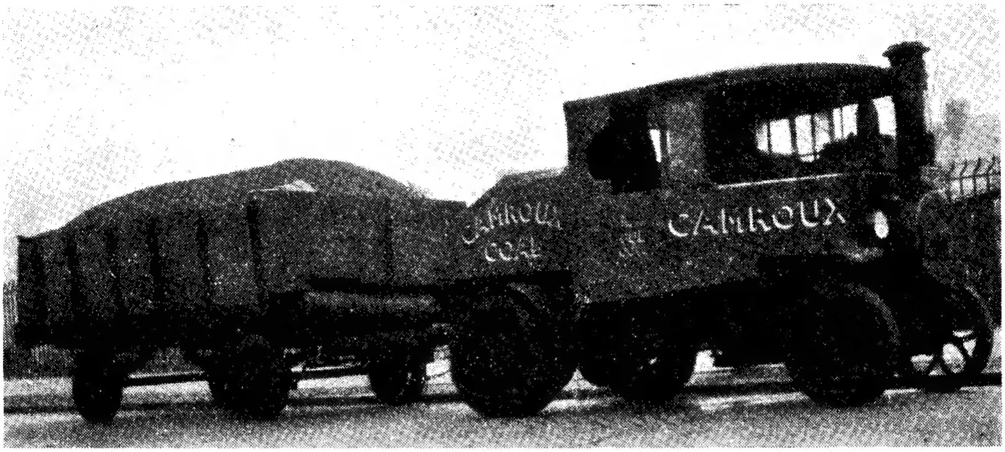
Of undertypes there is also a big choice. The Garrett, made in four- and six-ton forms, has a vertical boiler, control by an accelerator pedal, and two speeds with final drive by two chains. The water capacity is 180 gallons and the six-tonner can haul up to ten tons total at up to 12 m.p.h. The famous Sentinel of the period has two double-acting cylinders of 6¾ in. × 10 in. and develops up to 70 h.p. for short periods. It is easy to fire, the firebox can be lowered for inspection, and the drive is by direct chain with a differential gear incorporated in the crankshaft. The Clayton undertype is specially adapted for working in confined spaces. The vertical boiler operates at up to 230 lb. sq. in. and again a direct chain drive is used. A patent eccentric reversing gear enables the driver to control the angle of advance and throw of the valve eccentrics so that a full range of cut-off from zero to maximum is obtained by a simple movement of the control handle. A 12-ton six-wheeler Clayton is also available.

The Atkinson undertype, again, is chain-driven but if you dislike this form of drive there is the Mann with shaft drive; the Fowler with an inclined vee engine, shaft and worm gear drive; and the Yorkshire, which has a transverse instead of a vertical boiler, a vertical engine and gear or double chain drive. There is also a very short-wheelbase contractor's cart, made by the Mann Patent Steam Cart & Wagon Co., with overtype engine and all-gear drive.

In your conscientious endeavour to buy the best for your firm you will take your time and there are still the Aveling, Allchin, Burrell, Clarkson, Little Giant, Foster, Fowler, Leyland, Robey and others to consider; we will leave the final choice with you and

return to the internal-combustion present-day.

If the steam-wagon was holding its own with petrol in the nineteen-twenties, displaying splendid long-wearing qualities which a maximum engine-speed of little more than 200 r.p.m. fostered, if sometimes apprehended by the police for the "emission of visible vapour" (especially with a vertical boiler), today it has all but disappeared. Sad but true, I imagine that But so far no others have come to light. For loads up to about ten tons diesel-power rules supreme, although its acrid fumes are surely more unpleasant than "visible vapour"? Lack of skilled drivers, speed limits, and possibly the high tax—I noticed that the Camroux Foden pays £19 5s. per quarter—have killed off the steam-wagon. Foden turned to diesel lorries in 1930, Sentinel followed suit in 1946.



A good haul! The Camroux Foden seen near the Hammersmith Hospital, where it is delivering coal from its ten-ton solid-tyred wagon. Alas, it may be pensioned-off later this year

this article will produce evidence of far fewer wagons than my previous articles did of traction-engines.

The reason is, perhaps, not far to seek. The showman can make use of a road locomotive able to pull at least four times the load a steam-wagon can tackle and the farmer needs the compactness and great tractive power of the steam tractor for work on soft ground. In neither case does the wagon fit in. Consequently, few have survived. There is the gallant Foden with which I opened this outpouring. Many of the modern-style, poppet-valve shaft-drive undertype Super-Sentinels are still seen, satisfied users including the Gas Light & Coke Co., Hovis Ltd., and the British Cement Marketing Board. I am told that a former Foden agent in Kent kept some of these vehicles working in his quarries for old-times' sake, at all events up to a few years ago.

I would like to make a suggestion before I close. It is that steam enthusiasts amongst company directors whose firms have big transport fleets might save and restore the occasional steam-wagon. If put into commission occasionally such vehicles could earn their keep and the examples not yet broken up should be in comparatively sound order and easier to get back on the road than the cumbersome traction-engine. If a steam-wagon cult of this kind could be started amongst those with the facilities to store and operate such vehicles, no doubt an annual rally would follow, and once again all the friendly arguments about the relative merits of different types and makes—the pros and cons of the Joy's valve-gear of the Clarkson, or the Hackworth's radial of the Mann over that of the usual Stephenson's link motion, for instance—be once again heard about the land!

For the Bookshelf

Locomotive and Train Working in the Latter Part of the Nineteenth Century, Volume 2, by E. L. Ahrons. (Cambridge: W. Heffer & Sons Ltd.) 175 pages, size 6 in. by 8¾ in. Illustrated. Price 18s. net.

This second volume of welcome reprints of the late E. L. Ahrons' articles from the *Railway Magazine* deals with the London & North Western, the Lancashire & Yorkshire, the Midland, the North Stafford, the Furness, the Maryport & Carlisle and the North London Railways. It is uniform in style with Volume 1, and we note the same careful editing of the text, whereby none of the original "Ahrons" flavour is lost.

Forty-eight locomotive photographs are reproduced on twelve art-paper inserts; they have been well chosen and present a clear cross-section of the locomotive practice of the railways concerned during the period covered.

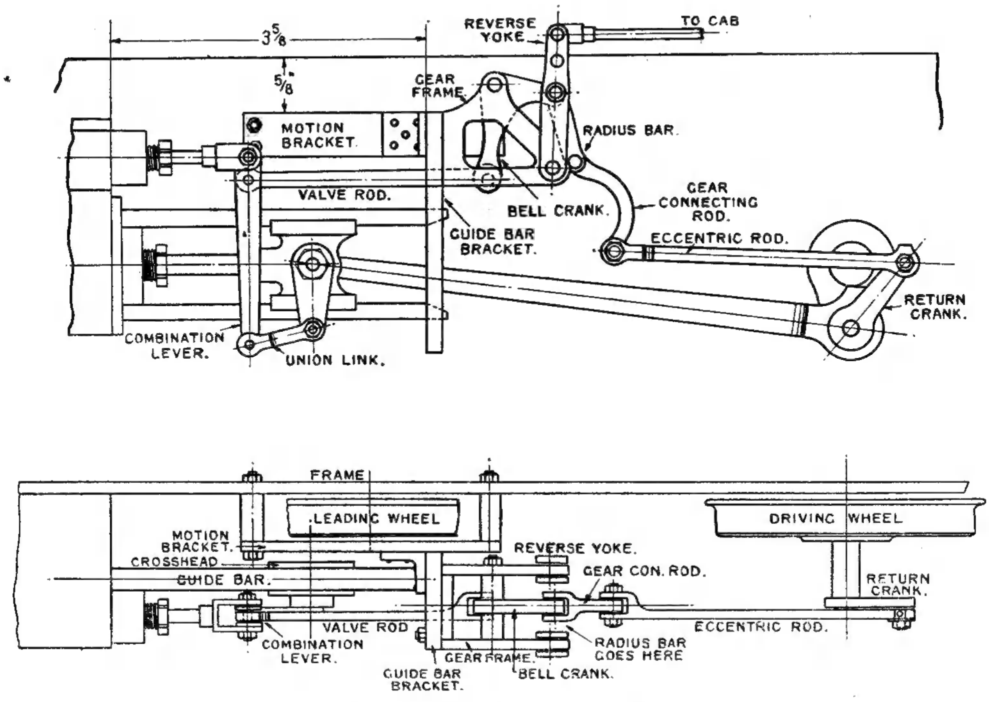
To re-read the text is refreshing indeed; the information in it is always illuminating and often amusing, while it gives a vivid picture of the railways as they were at a time when they were beginning to approach zenith of their pre-grouping glory.

"JULIET" WITH OUTSIDE VALVE GEAR

by "L.B.S.C."

Details of the Baker Valve-Gear

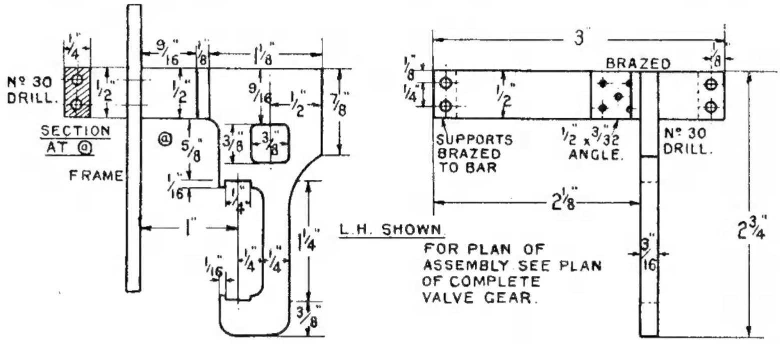
THE reproduced drawings of the complete layout of the Baker valve-gear for the revised edition of *Juliet* should enable all builders, tyro or experienced, to get a good idea of the job they are about to tackle. The observations I made about valve-gear in general, when commenting on *Britannia's*, naturally apply here also; but dieblocks to fit to curved slots. For the benefit of the uninitiated, I might mention here that the actual valve-gear, comprising the gear frame, reverse yoke, radius bars, gear connecting-rod and bell-crank, is "standard" size for any type of $3\frac{1}{2}$-in. gauge locomotive, to which the bracket-type gear can be fitted. The same working



Baker valve-gear for "Juliet No. 2"

this outfit is easier to make and erect. The brackets are simple and straightforward, easy to make from bar and plate material; but I shouldn't be at all surprised if two of our enterprising advertisers, who supply "approved" castings, get busy and make all three units—motion and guide-bar brackets, and gear frame—in a single casting. The valve-gear itself is comprised of simple links and rods, cut from plate or strip material, simply drilled and filed to shape; there are no curved and slotted links to make, and no components, housed in a girder frame instead of a bracket frame, will be quite suitable for an engine like *Pamela*, of which more anon. That is one of the great advantages of the Baker valve-gear. You just make up the set to "standard" dimensions, and hang it up on the engine in the most convenient place; whereas a Walschaerts, or other type, has to be designed for the engine. In full size, an engine might come in one night, off a run, with damaged or badly-worn gears; and the driver "puts it in

the book," or on the card, as the case may be. A couple of conscientious and enterprising fitters and mates get busy, and out come the complete sets, "lock, stock and barrel." Up go two new or reconditioned sets, and when the early-turn driver books on, hey presto! There she is, as good as new, all ready for him to take out. At least it would have been so with the boys we had on the L.B. & S.C.Ry. in the good old days; maybe, the present generation of maintenance staff would be scared stiff of being fined by the union for too much hustle!! Such is "progress" in the crazy world of today.



Motion and guide-bar brackets

How it Works

A full explanation of how the Baker valve-gear works is given in the *Live Steam Book*; but for the benefit of those who haven't read it, here is a brief resume. Two vertical levers, called reverse yokes, are pivoted at the bottom to the gear frame. In the present case these are double, for constructional purposes, one half inside and the other half outside the frame; but for all intents and purposes, each constitutes a single lever. On the inside of these, swinging from the middle of them, are two short links called radius bars. The lower ends of these are pinned to a sickle-shaped lever, called the gear connecting-rod, which swings between them. The upper end of the gear connecting-rod is attached to the horizontal arm of a bell-crank, and the lower end is connected to a return crank on the main crank-pin, in the same way as the Walschaerts eccentric-rod is connected to the bottom of the expansion link. The other end of the bell-crank is connected to the combination lever by a plain rod, like the radius-rod of the Walschaerts gear. The top of the reverse yoke is connected to the lever in the cab. That is all there is to it; simple enough, in all conscience.

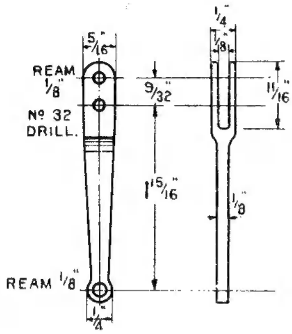
This is how it does the doings: When the reverse yoke is in mid-position, as shown in the drawing, the upper end of the radius bars, and the top of the gear connecting-rod, are in line with the end of the bell-crank. Consequently, if the wheels are turned, causing the eccentric-rod to waggle the gear con-rod back and forth, the top of same, and therefore the bell-crank and valve-rod, do not move. Now, if the reverse yoke is pushed forward, things begin to happen. The pivots of the radius bars are shifted ahead of the bell-crank connection; consequently, when the gear con-rod begins to waggle, it has to follow the movement of the lower ends of the radius bars, as it is pivoted to them. As the upper ends are now off centre, the back end of the arc, in which the radius bars swing, is higher than the front. This causes the gear con-rod to bob up and down, taking the end of the bell-crank with it, and causing the other end of same to actuate the valve-rod; and, via the connections at the top of the combination lever, the valve also. The gear con-rod, and the lower part of the bell-crank, will move in the same direction, and the engine will go ahead.

The Notching-up Effect

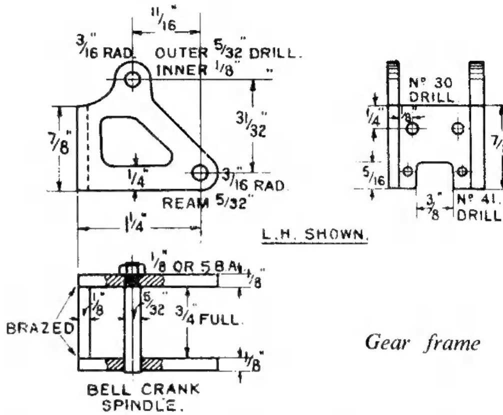
If the reverse yoke is now pulled back, the upper ends of the radius bars will be *behind* the bell-crank connections; consequently, as they swing, the arc described by the lower ends is higher at the front than at the back. The gear con-rod following this movement now pushes up the end of the bell-crank as it moves forward; whereas before, it pulled it down. The movement of the lower part of the bell-crank—and with it, the valve-rod, spindle, and valve—being now reversed, the engine goes backward. The lower part of the bell-crank, and the gear connecting-rod, now move in opposite directions; and when you erect the gear, and watch its action, you'll see why it is necessary to form the "sickle" in the gear con-rod. The bottom of the bell-crank wouldn't clear a straight rod. As the reverse yoke is moved towards the central position, from either full forward or full back (sounds like football!), the arc in which the lower ends of the radius bars swing, flattens out; the movement of the bell-crank becomes less and less, in relation to the constant swing of the gear con-rod, and so we get the notching-up effect. The gear merely reverses the direction of valve travel, and regulates the amount of port opening; the advance to lead, and the early cut-off point, is governed by the two joints at the top of the combination lever, same as in a Walschaerts gear. Well, so much for that.

Details of the Gear Applied to "Juliet"

Owing to a coupled wheel being directly behind the cylinders, between crosshead, guide-bars and frame, the bracket carrying the gear frame cannot be attached direct to the main frame, otherwise the eccentric-rod would be too short. The arrangement illustrated, enabling the gear frame to be located in a favourable position, is the same as I adopted for *Tugboat Annie*. The only difference is, that she has the girder type gear frame. An auxiliary motion bracket, consisting merely of a piece of bar, is attached to the frame by long bolts, with two distance pieces interposed, so as to prop out the bar, clear of the leading wheel. The latter works between frame and bar, as is clearly shown in the plan view. The yoke, or bracket, supporting the guide bars, is attached to this by a piece of angle, riveted and brazed, and is located at the ends of the guide-bars, just clear of the extreme end of the crosshead travel. The bracket-type Baker gear frame, complete with all the blobs and gadgets, is attached by four bolts or screws to the rear side of the guide-bar bracket. The whole bag of tricks can easily be dismantled in case of emergency, or for replacement of worn pins; but it will be a dickens of a time before the latter becomes necessary. Nine years of work haven't had much effect on the valve-gear of my *Tugboat Annie*; there is hardly any play in the gear at any point.



Combination lever



Gear frame

The reverse lever in the cab may be practically the same as described for the engine with link motion; but as there is no weighbar shaft in a Baker gear, and each side needs its own reach-rod, the lever will be connected to a cross-shaft at the footplate end. The lever will operate one gear direct; a vertical arm on the opposite end of the cross-shaft will operate the other.

There is another point, not connected with the gear, which, if I draw attention to it now, may avoid future misunderstanding. The overhead-valve cylinders, and the outside valve-gear, naturally project a considerable amount more than the cylinders with inside steam chests and valve-gear; ergo, as the Shakespearian actor would remark, the running-boards will have to be made wider, to cover the steamchests and the valve-gear. The tanks will also have to be wider, to match. This means that the ends of the running-boards will have to be sloped in, at each end, to meet a $6\frac{1}{2}$-in. buffer beam; no detriment at all, because many full-sized engines have this arrangement, for platform clearance on curves, and similar purposes. However, if anybody wants running-boards, the same width from end to end, they should make their buffer beams $7\frac{1}{8}$ in. long, and then we shall all be happy. This will allow a running-board $2\frac{1}{8}$ in. wide, and it will well cover the gear. As an alternative, the running-boards could be dispensed with altogether, and as the revised *Juliet* has a flavour of Swindon about her, pannier tanks could be fitted, and she would then become a four-wheeled version of the last lot of Great Western shunting tanks.

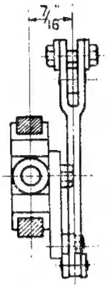
Motion Brackets and Guide-bar Brackets

If castings *should* be available, they will only need cleaning up with a file, and drilling for bolts and pins. If not, use steel plate, or ready-sheared strip. The motion brackets each need a piece of $\frac{1}{2}$ in. $\times$ $\frac{1}{8}$ in. section, 3 in. long; the ends should be squared off by clamping them both together in the four-jaw, and facing the ends with a roundnose tool set crosswise in the slide-rest. The distance pieces are made from $\frac{1}{2}$ in. $\times$ $\frac{1}{4}$ in. section, and are $\frac{9}{16}$ in. long; either part off in the four-jaw, or saw to full length and face the ends truly in the chuck. Rivet them temporarily to the ends of the pieces of bar, by a long rivet made from a bit of 3/32-in. iron wire. No fancy heads needed, just burr over tightly; the ends of the rivets are filed flush after brazing.

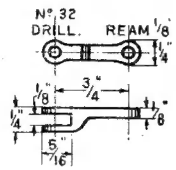
The guide-bar yokes or brackets are made from mild-steel $\frac{3}{16}$ in. thick, and are $1\frac{1}{8}$ in. wide and $2\frac{3}{4}$ in. deep. Shape and measurements are all given in the appended illustration. They may look a bit tricky at first glance, but they aren't, really, because the only absolutely vital dimensions are the location of the grooves for the guide-bars, and the $\frac{1}{16}$ in. lips at the edge of same. The brackets must not squeeze in the bars, or the crossheads will bind; nor must they allow the bars to splay out, or the glands will rapidly wear oval, and continually blow,

whilst the crosshead will rock, and cause undue wear on the piston-rods. The hole for the valve-rod to pass through is very easily made; mark the spot, drill a $\frac{3}{8}$ in. hole, and file it square, leaving the corners rounded (says Pat).

Each bracket is attached to the 3-in. bar, by a piece of $\frac{1}{2}$ in. × 3/32 in. steel angle. If you haven't any regular angle of this size, don't fret, simply bend up a bit of 3/32 in. × $\frac{1}{2}$ in. strip steel in the bench vice. Rivet it to the guide-bar bracket with three $\frac{1}{16}$-in. rivets (bits of iron wire will do fine) then set it at $2\frac{1}{8}$ in. from the leading end of the motion bracket. Hold in place with a toolmaker's cramp, set the two



How combination lever clears crosshead



Union link

brackets (motion and guide) at right-angles with a try-square, and rivet up with three $\frac{1}{16}$-in. rivets as before. Just bang the heads over, so that everything is tight. Now braze up the lot, solid; just anoint the joints with wet flux, blow to bright red, and apply a bit of soft brass wire, about 16-gauge. Let it flow into the joints well. If you are a pal of Inspector Meticulous, coarse-grade silver-solder can be used, or "white" spelter, so that the brazing material is practically invisible. Let cool to black, quench in water, and clean up, filing off the rivet heads. Warning: don't forget you need one right-hand assembly, and one left-hand; mistakes are easily made!

The sides of the gear frames can be cut from $\frac{1}{8}$-in. steel plate, two pieces about $1\frac{1}{2}$ in. square being needed. Mark one out very carefully, and drill the holes No. 41; use it as jig to drill the second plate, rivet together with 3/32-in. rivets, then cut out both plates together. Open out the holes with No. 30 drill, then clamp the plates temporarily together, at the correct distance apart, by making two long bolts (bits of $\frac{1}{8}$ in. round steel $1\frac{1}{4}$ in. long, screwed and nutted at both ends) and using pieces of tube, squared off in the lathe to $\frac{3}{4}$ in. full length, on the bolts between the plates, as distance pieces. The end plate is then cut out and drilled as shown, and fitted between the side plates at the front end; braze in position, quench in water, and clean up. Three of the holes are reamed 5/32 in., but the top inner one is left with the No. 30 hole in it. Don't forget, again, that as this smaller hole is on the side of the gear frame nearest to the main frame, it must be on the right and left-hand sides of the gear frames respectively.

When the whole issue is erected, these gear frames will be attached to the rear sides of the guide-bar brackets; so clamp each one in position, and drill the bolt holes in the brackets, using the holes in the ends of the gear frames as a guide. The position of the whole assembly is shown in both elevation and plan of the complete valve-gear. There is no need to bolt up permanently until the parts of the valve-gear are made and fitted to the gear frames; but the motion brackets may be located on the main frames, and the holes drilled for the long bolts. First drill the two No. 30 holes in each distance piece, as shown in the illustration of the guide-bar bracket; these holes, of course, go clean through bar and all. Now put the brackets in position, the ends of the guide bars just entering the seatings in their brackets; this will automatically locate the height of the assembly. Tip: have the crosshead as near the end of the guide bars as the stroke will allow; that is, the crank on back dead centre. Now adjust the assembly until the guide-bar bracket is exactly $3\frac{5}{8}$ in. from the end of the cylinder, and the bar of the motion bracket parallel to the top of the frame. Hold in this position with a toolmaker's cramp, and drill the bolt holes through the frame, using those in the distance pieces for a guide. File off any burrs, but don't bother to attach permanently yet, though you can make the bolts all ready for erection when the time comes. They are just pieces of $\frac{1}{8}$ in. round steel, screwed both ends $\frac{1}{8}$ in. or 5 B.A. and furnished with nuts.

Anybody who has caught up, and is stuck for a job, can carry on with the combination levers and union links, which are illustrated here, and need no detailed description, as they are made in the same way as I have already fully described for *Tich*, and referred to in the notes on *Britannia*. The combination levers are made from $\frac{1}{4}$ in. × $\frac{5}{16}$ in. mild steel, or $\frac{5}{16}$ in. square would do; the union links from $\frac{1}{4}$ in. square mild-steel.

The Lowne Engine—Postscript

Shortly after passing the proofs of my article on atmospheric engines, an early catalogue of the Mechanical Engineering Collection at the Kensington Science Museum suddenly appeared among my technical books and this contained a description of the Lowne engine—not, however, accompanied by a sectional drawing—which is what I would wish to have placed before readers. Since this description is not set forth in very clear language, I shall content myself with a few extracts with the hope that the reader will not have too much difficulty in following their meaning!

Very well then—" The inner end of the trunk is guided by a ring fitting the cylinder and the outer end by guides on the framing . . . the piston drives a crankshaft with flywheel and pulleys by means of a jointed connecting-rod, the joint being attached to a radius-rod which takes from the cylinder and guides the oblique thrust of the short lower portion of the connecting-rod, and also serves to operate the valve." I do sincerely hope that all this can be followed. My feeling is that the illustration leaves one better informed than the above descriptive matter!

—B.C.J.

GEAR CUTTING BY HAND MILLING

by George Gentry

THE term "hand milling" is used here to define the method of operating ■ rotary milling cutter by direct hand power. This is only possible when milling light work in the lathe, and it requires ■ crank of sufficient throw to obtain the leverage necessary for clean cutting. The hand drive eliminates the need for an overhead gear or other independent drive which, if applied directly to the cutter spindle, is not satisfactory for driving multi-edged cutters, being usually too fast and having insufficient torque to transmit the cutting power by means of a belt drive of any kind, unless ■ geared cutting spindle having a sufficiently low gear ratio is incorporated in the equipment. This refinement is rather expensive and is not usually needed sufficiently often to be justified. In any case, as will be described later, the cutter must be mounted on some form of spindle free from either side- or end-play and housed ■ running fit in ■ suitably shaped shank to be clamped firmly on the slide-rest.

Methods of Milling

There are two methods of applying milling cutters; the more general is to have the rotary cutter mounted on the spindle of its machine, whether a milling machine or a lathe, and held rigidly as to its position. In this case, the work is mounted on a dividing fixture which can be traversed in a direction against the direction of rotation of the cutting edges of the tool. This method can be applied on ■ lathe, and is the only method normally used on ■ milling machine. The other method is to have the cutter mounted on ■ rotary spindle fixed on the slides of the lathe and operated by some form of independent drive. In this case, the work is mounted rigidly on the mandrel or between the centres of the lathe. The traverse is applied directly to the rotating cutter and its direction must be in the same direction as the cut of the tool. This question of direction of traverse in relation to direction of cut is most important because, unless the traversing slides are entirely free from backlash, the

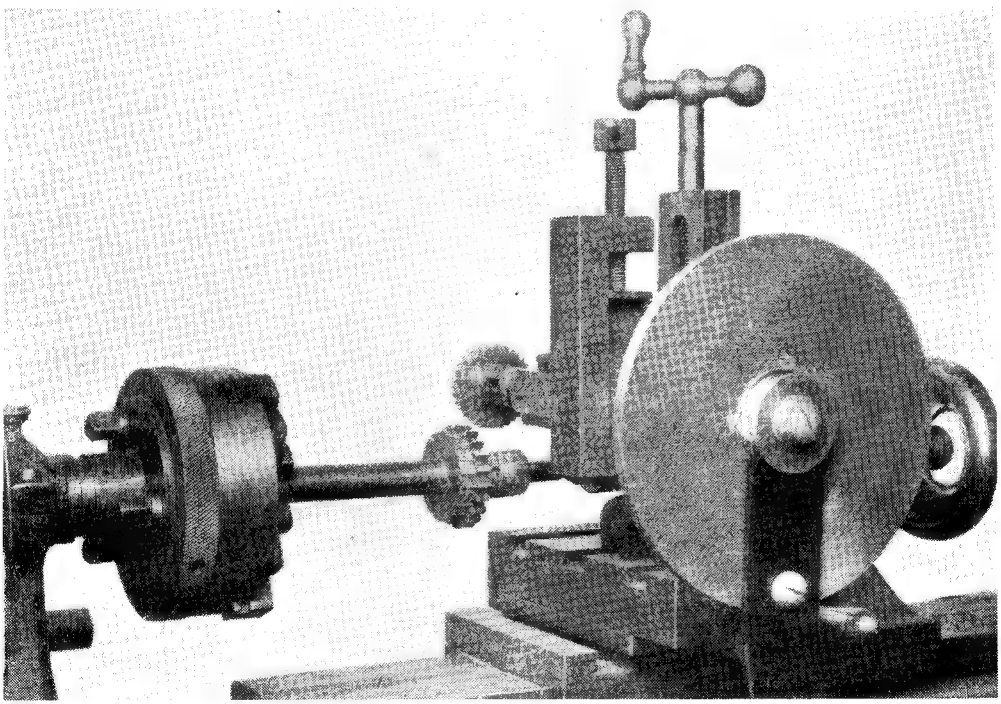


Fig. 1. Setting-up of cutter and blank for hand milling a 21-tooth 16 d.p. change wheel

cutter will gather the backlash of the traversing screws (which nearly always have a square thread) and cause a dig-in, probably shifting the work or breaking off the tool of the cutter. As a matter of fact, in lathe work, any traverse which deepens the cut of the tool is called the feed, and in this second method of applying the milling cut, the effect of accelerating the traverse does have the effect of deepening the cut. This is not, strictly speaking, the feed proper, which is effected by mounting the cutter spindle, on a verticale slide, and the traverse in a vertical direction thus obtained is really the feed. The cross traverse of the lathe is generally only used for positioning the cutter, at any rate in gear cutting.

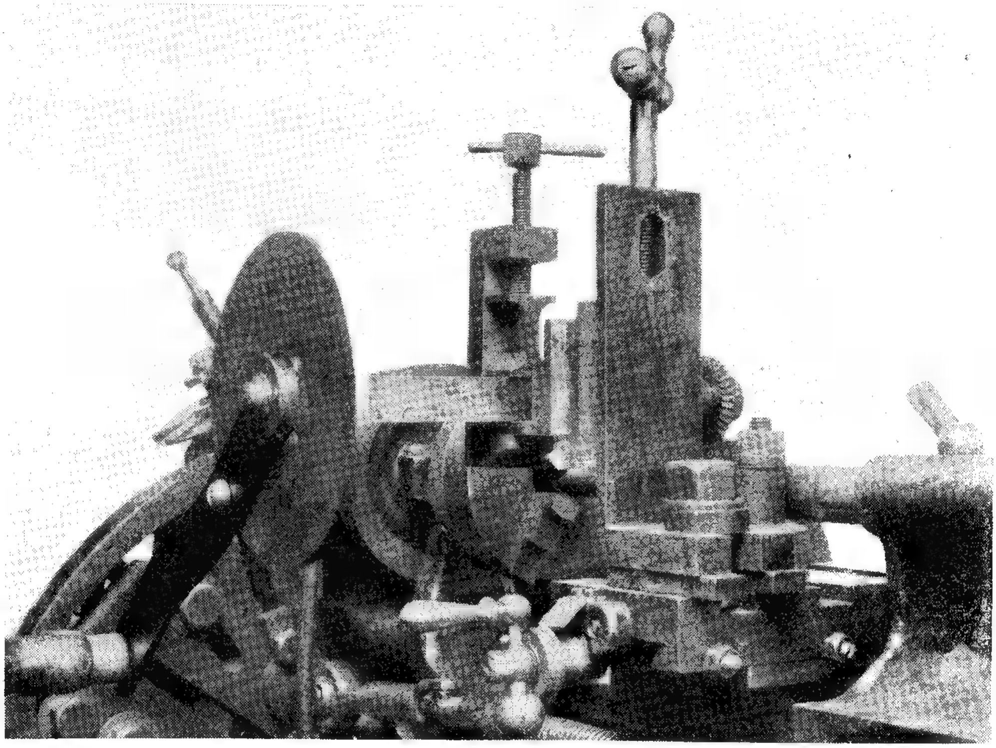


Fig. 2. Taken at the tail end front of lathe. Shows the vertical slide mounted on the cross-slide saddle, and put on packing to clear the lock-nutted screw end

Gear Cutting Procedure

Gear cutting is the operation of removing, by milling or shaping, the space between teeth from a circular blank of appropriate size to suit the given pitch and number of teeth in a gear wheel. The blank is held rigidly during the cutting, but between each cutting operation, which may be either to partial or full depth of space at once, the blank is set free in the direction of its rotation only, and revolved one pitch distance by means of some form of dividing apparatus, axially set in relation to it, and again locked against rotation.

The question of gear teeth proportions and the shape of teeth do not concern us immediately here, and the question of a suitable means of dividing will be briefly referred to later. The milling process is carried out by a suitably shaped cutter which, to be stirctly accurate, should be of a differently curved shape for every different number of teeth of a given pitch from a pinion of 12 to a wheel of at least 135 teeth or more. This, however, would entail the need for such a large number of expensive tools for only one pitch of tooth that a sort of compromise has been effected by cutter makers, wherein only eight different shapes are made to cut the entire range of numbers from 12 teeth to a rack (the latter being regarded as part of a wheel having an infinite number of teeth or a blank of infinite diameter). This applies to that system of gear cutting known as "involute," wherein each individual tooth side forms a single curve of involute shape from root to crest, and the correct shape of the sides of teeth of a rack are straight lines at an included angle of 29 deg.

There are other systems of gear cutting, but in this system a No. 8 cutter will cut only wheels of 12 and 13 teeth, No. 7, 14 to 15 teeth, No. 6, 16 to 20 inclusive, and so on with increasing range of numbers down to No. 1, which is designed to cut 135 teeth and any greater number up to a rack. This No. 1 cutter is very slightly

curved, an advantage in cutting rack teeth which require to be slightly clearanced at the points, if they are to be geared with components of 12, 13 or 14 teeth.

The working principle now used in gear cutting under manufacturing conditions is by a process of shaping, using a single point cutter shaped as for a rack tool space. This cutter is gradually traversed between cuts by moving its ram horizontally sideways, while the wheel blank is correspondingly revolved, in the same direction, at the same velocity ratio taken at its pitch circle circumference. If carried out in both directions and returned to zero, this results in generating an accurate shaped tooth. The movements are usually effected by automatic action of a complicated nature. From this point, the blank is indexed to one tooth and the shaping process repeated. This method, however, is hardly practicable with the means to be described, and therefore does not concern us further at this point.

Setting Up the Cutter Spindle

Fig. 1 is a view of a gear cutting setting in which a 21 tooth 16 d.p. change wheel has been cut on the writer's lathe. The blank of phosphor bronze is only half-gear width to save time and trouble in cutting, and it is mounted on a true arbor held firmly in a self-centring chuck. The dividing is done by a worm dividing gear on the tail end of the mandrel. to be described later. The cutter is mounted on the nose of a drilling spindle, which has opposed cone bearings of hardened steel, mounted at each end in a $\frac{9}{16}$ in. square steel shank 5 in. long. This spindle has a length of rather over 7 in. of which the cutter occupies 1 in. beyond the end of the shank, with the intervening enlarged part of the spindle slotted across to take fly cutters, moulding cutters and so forth, as used in ornamental turning. The tail, or inner end of the spindle, is $\frac{7}{8}$ in. over-all length, and carries a 1 in. vee-pulley, the inner vee side of which is enlarged to form a $1\frac{1}{2}$ in. flange which provides a convenient face on which to mount a larger pulley if required. It was decided to mount some form of handle on this flange. The making of a crank handle of 5 in. or 6 in. throw is not an easy matter to do quickly, but the writer happens to have a double-geared breast drill brace, on the large bevel gear of which a suitable handle is mounted by means of a single screw through its web, fitting a tapped hole

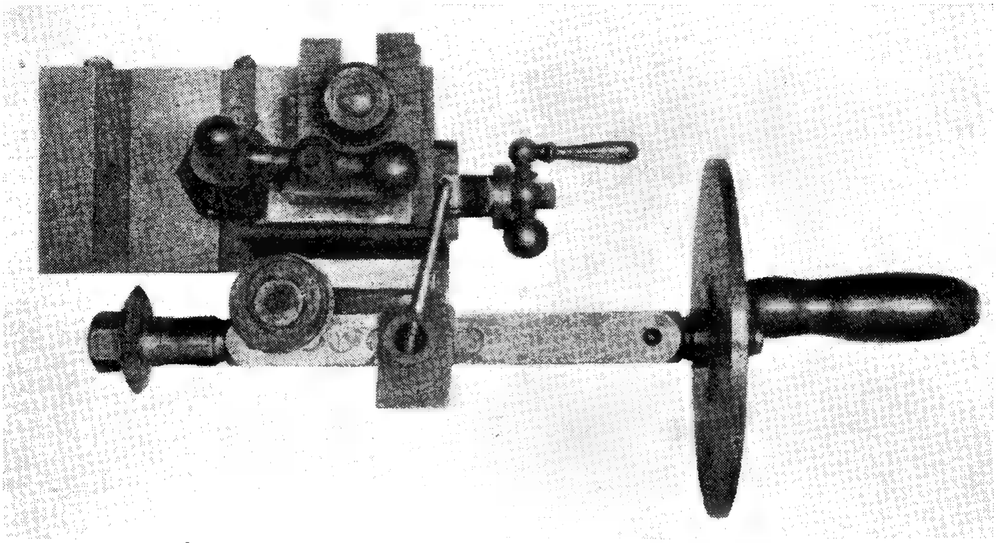


Fig. 3. Plan photograph of the whole spindle setting on cross-slide saddle removed from lathe

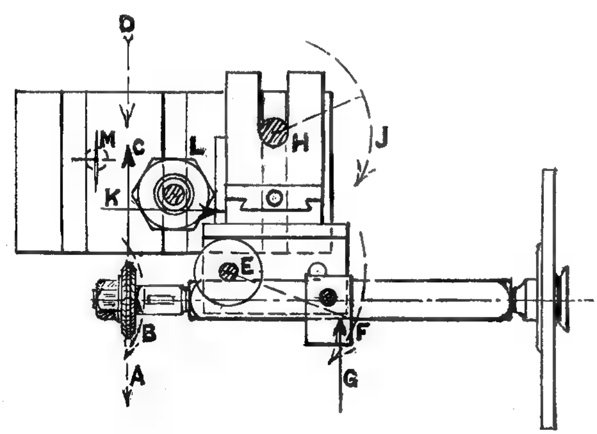


Fig. 4. Diagram showing the turning effect on clamps and bolts in the setting

in the face of the wheel. The radial location of the handle is fixed by being concave curved at its centre end, which cavity fits into a groove on the fixed boss of the wheel. This was removed in a matter of a few seconds, and found to be readily adaptable to the pulley of the drilling spindle, requiring only an auxiliary crank arm or, as shown, a disc mounted on the flange to contact the driving screw. The latter was ultimately cut from a piece of regulator clock plate 5/32 in. thick, which acted not only as a carrier, but to some extent as a flywheel.

The Vertical Slide

The spindle is mounted, as shown, on the horizontal face of an angle steel table, and attached to the saddle of a vertical slide. It may be mentioned that this accessory is of forged steel and

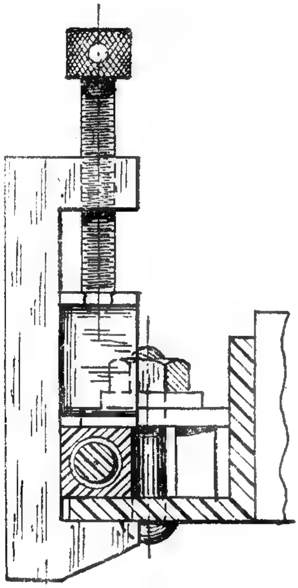


Fig. 5. Sketch showing the clearance between the vertical stop and edge of table ; also, stop action of clamp-bolt

was made in the old M.E. workshop during the first world war. It would be on the slender side if made in any other metal than steel, unless stiffened by angle webs, as would be normally provided in a casting. The photograph, Fig. 2, taken at the tail end at the front of the lathe, shows how the angle steel table extends sideways of the vertical slide saddle, and Fig. 3 is a plan view of the spindle setting. In all these views, the top-slide of the lathe has been removed.

Use of Stops

Few things are more annoying in the workshop, or tend to make the craftsman want to tear his hair, than for work which has been very carefully and meticulously set up, to shift under the stress of the applied cut. This is very liable to occur in cases where the nature of the work or fixtures does not allow of fitting more than one clamp, and in this case the work may tend to swing round the centre of pressure, however it is bolted. In clamping work to shaper and planer tables, it is nearly always found necessary to fit a dead stop at the moving end of the work. Sometimes a clamp is fitted, sloping up buttress fashion, or a clamp may be improvised to act as a stop, so long as it can be placed so as to avoid fouling the cutting tool. Some provision of this nature should always be used when mounting the cutter spindle or other fixture for milling in the lathe. A fixture which appears perfectly rigid, when tested by steady pressure, may be found unsuitable for dealing with a "live" load, which means a force of movable, rapidly varying or vibratory nature, such as the resistance to the cut of a multi-edged milling cutter.

Security Measures

This applies particularly to the little milling job we have in hand here. As a matter of fact the writer at first failed to use any stops in clamping down the milling spindle and found that, immediately the cut was applied, the vibration started to move the spindle shank out of the outer clamp which was bolted through the angle table in the same way as the inner clamp. This, of course, moved the cutter from its correct position, and work had to be stopped immediately while further security measures were planned. This explains the fitting of a tool-maker's vice clamp at the outer end of the angle table, and the diagram, Fig. 4, which is below the plan view Fig. 3 and corresponds to it, will explain the position shown, as far out as is practicable. The direction of rotation of the cutter on its underside is indicated by the curved, dotted arrow *B* and makes its cut in the direction shown dotted at *A*, the vibratory force in resistance to the cut being in the direction *C*. The direction of traverse of the appliance is shown dotted at *D*. The inner clamp on the angle table is bolted at *E*, and the turning moment, about *E*, is the force *C* in lb. multiplied by the normal or vertical distance to *E* in inches, the result being in in./lb., which is the usual way of expressing torque, and defines the leverage against the bolt *E*. The effect at the other end was in the direction shown by the curved dotted line *F*, and one can now see how another clamp in the bolt hole in the angle table was of no use whatever. It required a dead stop at *G* as well as the clamp, so that in the sketch, Fig. 5, the vice clamp fulfilled the necessary requirements, and the shank never moved again. As seen in Fig. 5, the outer side of the cutter spindle shank, shown in section, is set just proud of the outer edge of the angle table, also shown in section, and it bears dead against the bolt at *E* at the other end of the table, and the vice clamp is closed firmly on top of the shank. Note in Fig. 4 that the normal distance from *E* in direction *G* is greater than *E* is from *C*, hence the force straining on the stop is less than at *C*, and it would be still less if one could put a stop right out at the end of the shank near the handle disc.

Referring to the turning effect of the main bolt holding down the vertical slide at *H*, this is nor-

mally further from C than is E, and therefore the torque is greater, the effect being to turn the whole slide in the direction shown dotted at J, and needing a very firm stop at the position K. The main bolt H is headed in the outer of the three cross-slots of the lathe cross-slide table, and the stop is put in the centre cross-slot. For this purpose, a $\frac{5}{8}$ in. faced hexagon nut L is bolted down firmly, between a corner point of which and the face of the inner edge of the foot of the vertical-slide is wedged a strip of steel bar, $\frac{1}{2}$ in. $\times$ $\frac{3}{16}$ in. The slide never moved this stop, nor could it move its own bolt, which is as large as the slot in the base.

Finally, no stop is necessary between the cross-slide and the main saddle table top. Both are planed and scraped to true surfaces, and the fixing bolt between, shown dotted at M Fig. 4, has no appreciable turning effect from the force C, which is only at a normal distance of $\frac{1}{2}$ in. from it. This joint is positioned to stand against resistance to the cut in ordinary turning with a tool in the slide-rest.

Not So Simple!

Although, at the outset, this job appears to be a simple matter, it is only when an inexperienced reader starts to carry it out that he finds there is more in it than meets the eye at first. For instance, one must realise that it is fatal when hand milling, especially gear cutting, to pause or halt in the regular revolution of the cutter, and not to vary the rate of traversing at the same time. The cutter ceases, first during the pause or halt to cut its way across, or the traverse puts it forward into cut with a very great likelihood, on resuming the cutting, for the cutter to dig in, tending to mount the work or possibly shift the setting or break one of its teeth. It is a very good thing, if anything untoward happens like this, to stop and even reverse the traverse first of all. It should be noticed that in screw-cutting, where the traverse and cutting revolution are geared, the first worry mentioned cannot happen, whereas the stopping and reverse of traverse cannot also be done with the lathe running. Another matter to which attention must be paid is the adjustment of all the slides, especially the vertical slide which, if not adjusted up so that one can just move it, is liable under the weight it is carrying to drop on its own backlash and upset the depth of cut. Fig. 6 is a close-up of the worm divider, part of which is seen in the confused back-ground of Fig. 2. As set in the photograph, the single thread worm is geared to a 40-tooth worm wheel, and to divide 21, the 42 circle on the division plate is used thus: $40/21 = 1\ 19/21 = 1\ 38/42$, there being no 21 circle in the set of plates. The sector arms are therefore set to count 38 negatively by their backs. This gear, together with the screw-cutting attachment, including the quadrant, will form the subject matter of future notes.

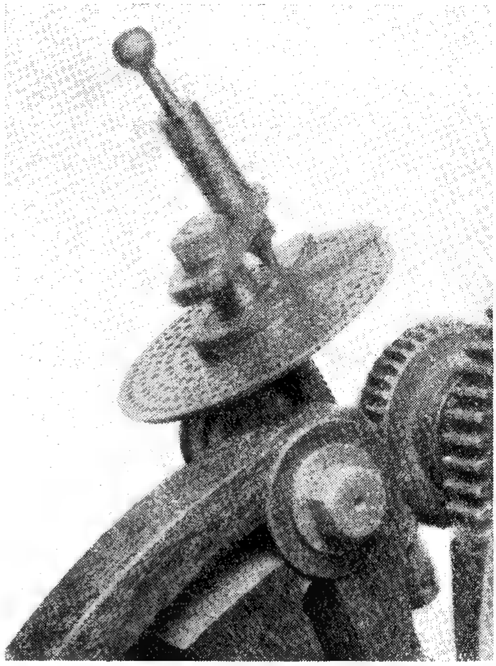


Fig. 6. Close-up of the worm dividing attachment, mounted on an oak quadrant

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Cutting Multi-Start Threads

THIS method I use to cut multi-start threads may be of interest to many "M.E." fans. I have an "Exacta" Jnr. that required a new thread on the front focussing cell. Having turned off the old thread, I set to, to find out the thread required. It was 0.5 mm. three-start thread. Having set the tool and gear train, I next set the compound slide at zero (0). I then proceeded to cut the first thread to the full depth; 0.5 mm. is 19.7 thou. pitch—20 thou. is good enough. The compound slide was then turned to 20 and the thread cut as for first. I then turned the slide another 20 thou. to 40 and proceeded as before; if the thread is slightly tight, the whole procedure may be repeated until the thread is correct.

The bore was 0.0005 smaller than the focussing mount, and heated by placing the new thread ring close to an electric lamp and pushed home by finger pressure. A negative enlarged 10 diameters showed no sign of misalignment.—W. V. CORNE.

A Split-Single Two-Stroke Engine

An efficient unit for propelling a class "C" Hydroplane

by R. E. Mitchell

THE American design and British copies of what has now become known as the "modern racing engine" suffers from one major defect. It is unreliable. No doubt the high output figures at speeds of the order of 15,000 r.p.m. are realised on the test bench where the load may not be applied until these high speeds are reached and the jet needle can be very carefully adjusted in order to give the maximum output.

When one of these engines is put into a car or a boat, the majority cannot be persuaded to give of their best. The rules governing model car racing allow as many laps start as the owner desires to attain maximum speed, or if the engine is particularly slow off the mark the car may be lead manually by means of the tethering cable. In boating circles conditions are considerably more difficult. Half a lap (i.e. 50 yards) is all that the rule allows before timing begins. Unlike cars, the highest demand on the engine is at the start where the propeller blades are working at an unfavourable angle of attack and the hydroplane is behaving as a displacement boat. To avoid this the technique appears to let the engine race at very high speed, which can only do it considerable harm if not wreck it altogether and hurl the boat forward hoping that the engine will maintain its high revolutions. More often than not the launch is faulty or the surface of the water is blamed for the fact that the revs. do drop and the engine splutters its way round the course or fails to complete the distance. Starting this type of engine also appears to be extremely difficult and is possibly the reason why mechanical starters have become popular.

If the published b.h.p. curves of the engines in question are examined they only start at about 8,000 r.p.m. and when they are produced to meet zero they give a complete curve of the type shown in Fig. 1. Compared with the curves published for lapped piston engines, also shown in Fig. 1, they show that at the lower speeds the engines fitted with ringed light alloy pistons show a surprising lack of power. It may be argued that full-size racing engines show a similar tendency but here drivers and gearboxes can ensure that the r.p.m. are kept high. These engines also start with comparative ease. It is possible that the poor startability and low speed characteristics are due to the aluminium alloy piston's inability to seal effectively the transfer port from the exhaust port, at least when the engine is relatively cool. The ports have crept further and further round the cylinder periphery to increase the power at the top end of the scale, losing sight of the fact that the engine has to attain these revs. to be of any use. The lack of power is not apparent in engines fitted with solid steel or cast-iron pistons because here the piston clearance is of the order of one-tenth of that which has to be given to aluminium alloy pistons to allow for expansion at the working temperature. The clearance allowed for the rotary inlet valve is not such a bad offender because this is more effectively sealed by the liquid fuel/oil mixture. A fact which supports this theory is that an engine of this type is easier to start with glow-plug than if spark-ignition is employed. With spark-ignition, by the time there is enough fuel and oil to effectively seal the ports the plug electrodes have become drowned so that no spark takes place. At M.P.B.A. regattas silencers are compulsory and these are objected to by some users of this type of engine because it is more difficult to get rid of the excess fuel after flooding so that the process may be repeated. Also, the familiar expedient of priming through the exhaust port cannot be done so easily in these circumstances.

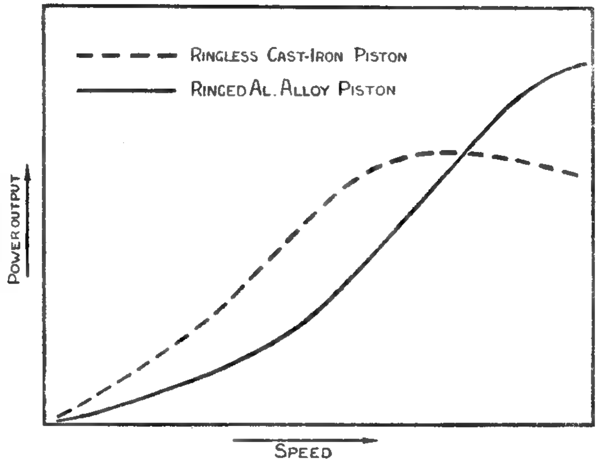


Fig. 1. Power outputs of plain cast-iron piston, and ringed light-alloy piston

The starting difficulty is not due to an over-rich mixture since with methanol (the most usual fuel) the correct mixture is obtained at 65 deg. F. while the lowest combustible mixture occurs at

45 deg. F. A glow plug, on the other hand, will continue to glow even in such wet circumstances and the engine will consequently start easier. Starting the car on its run appears to be done on an over-rich mixture and it is allowed to run until the mixture has weakened by which time the speed may have been built up. It is possible that the high centrifugal forces, which are set up on small circular tracks, acting on the fuel level, thus giving a large variation in mixture strength, may be a decided advantage. Somewhere during the run the mixture is slightly on the rich side to give the maximum power output so enabling the quarter mile or so to be timed. In the hydroplane field the centrifugal force is considerably lower and its effect is not so pronounced, with the result that the whole run is most likely done with a very rich mixture and maximum power is never attained. A boat will occasionally run out of fuel a lap or so after the timed distance and, in some instances, the speed will increase considerably for the last fifty yards or so immediately before the fuel tank is empty.

It is quite likely that such a boat would have petered out had the mixture been weakened at the start. The overall performance of one well-known hydroplane engine has been improved out of all recognition by replacing the aluminium alloy piston with rings by a piston skirt of cast-iron minus the rings. It is more than likely that the maximum output has been reduced by an increase in the mechanical friction, but very definitely output and reliability at the lower end of the scale have been improved. The engine referred to is that fitted to *Sparky II* and built by Mr. G. Lines, of Orpington.

To readers of Mr. Westbury and regatta reports in THE MODEL ENGINEER since the Class "C" (10 c.c.) hydroplane was introduced, it will be noted that this type of craft is usually extremely unstable. It has been argued that the high power/weight ratio is responsible. Under the usual regatta conditions obtaining in this country this is not the case. It is not certain what the effect of the weight of the boat is on the power required to drive it.

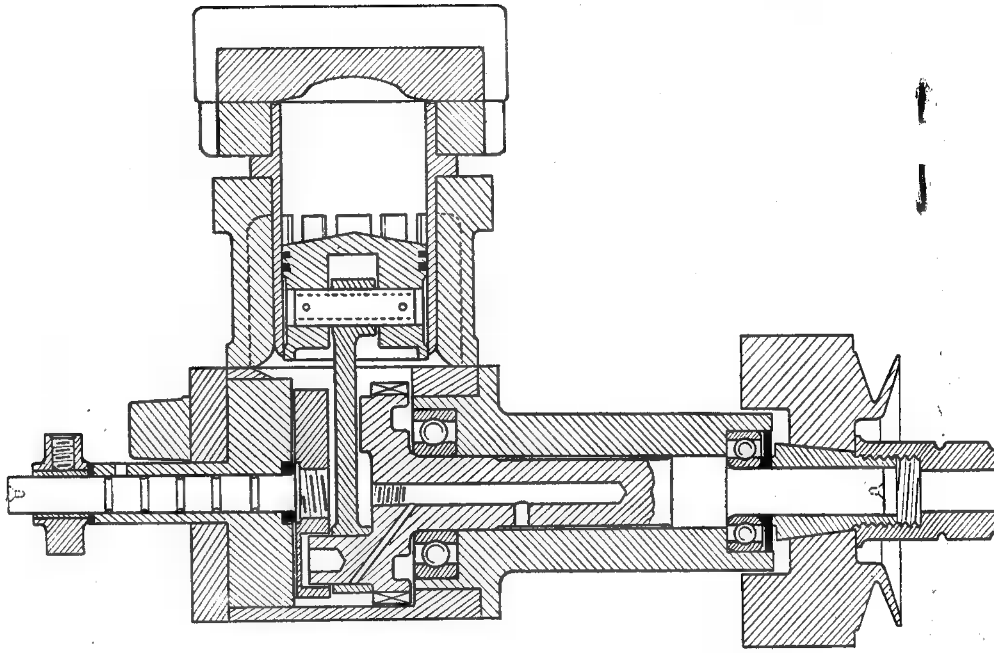
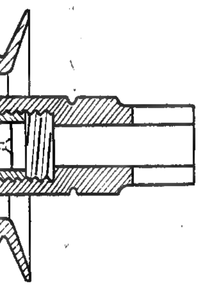


Fig. 2. Longitudinal section through transfer cylinder and crankshaft ; full size

The Class "B" hydroplanes, *Beta* and *Beta II*, were powered by the same o.h.v. four-stroke engine which, when first assembled, had a power output of slightly over 1.5 h.p. It is quite possible that with subsequent running this has increased somewhat. Both these boats were fairly heavy for their class, being of the order of 8¼ lb. and were propelled fairly consistently in almost any conditions at about 45 m.p.h. The average Class "C" hydroplane weighs no more than half this figure, but speeds at regattas above 45 m.p.h. are a rarity. Therefore their engines could not have been developing their full output of 1¼ h.p. + of which they are claimed to be capable. There is such a wide variety of hull design that the hull cannot be held responsible. Under competitive conditions the roughness of the water is the same for all classes of boats and obviously the heavier the boat the more stable it can be expected to behave. The introduction of surface propellers has also increased

the instability of hulls, but this has been more pronounced in Class "C" because since the boat is inherently more unstable the propeller leaves the water more frequently. This means that the torque reaction on the hull and the side thrust on the stern, obtained by the use of surface propellers, are alternatively applied and removed as the hull bounces in a vertical plane. Also, when the propeller is thrown clear of the water the thrust is removed which further increases the

and one combustion chamber are used. The intention, originally, was to use two carburettors; but this was not considered very practical, so instead, a manifold connecting the two inlet ports is used. It varies from the more usual design of this type of engine in that there are two crankshafts which are synchronised by making the crank discs ■ pair of spur wheels. Internal gearing is preferable since general engine "petroil" lubrication can take care of them.



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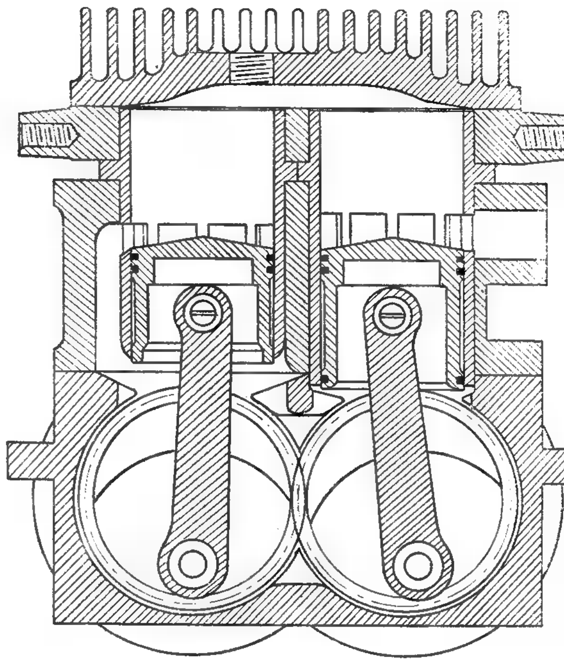


Fig. 3. Transverse section through both cylinders; full size

vertical instability. This type of instability can be minimised by the careful attention to the planing angles (most appear to fit planes at too steep an angle) and the position of the centre of gravity. It follows that ■ large contribution to stability could be made by the removal of side thrust on the stern and the torque reaction on the hull. The only method of eliminating those effects would be to fit two propellers running in opposite directions. Any method of transmitting the power to two shafts through gears from one engine was considered to be too inefficient. Using two engines with synchronising gears on the flywheels was considered. Since each engine would be of 5 c.c. capacity and almost certainly ■ two-stroke in this size it would probably suffer from the faults previously assigned to this type of engine. A convenient way out was found in which essentially two engines are used, and is ■ variation of ■ principle used in several full-size designs. The general arrangement of the engine is shown in Figs. 2 and 3.

It consists of duplicating everything except that only one transfer passage, one exhaust port

The slight displacement of the pistons, in which one controls the transfer port while the other takes care of the exhaust can be conveniently achieved by orienting the gear teeth differently on the crank discs. Choosing a suitable number of teeth governed by the angle of displacement required and displacing the wheels by one tooth will give ■ similar effect. If the constructor makes his own gearcutting tools ■ non-standard diametral pitch can easily be used, and this was the method adopted in the present case. A usual timing of port events for a two-stroke may be to open the exhaust port 65 deg. before bottom dead centre while the transfer opens 55 deg. before b.d.c.

The closing takes place at similar angular displacements after b.d.c. This type of timing is shown in Fig. 8. With the simple two-stroke it is impossible to vary the symmetry of the timing which is not the most efficient that could be desired; the transfer possibly opening too soon after the exhaust while some charge is possibly lost by closing the exhaust port after the transfer port has closed. Considerable experi-

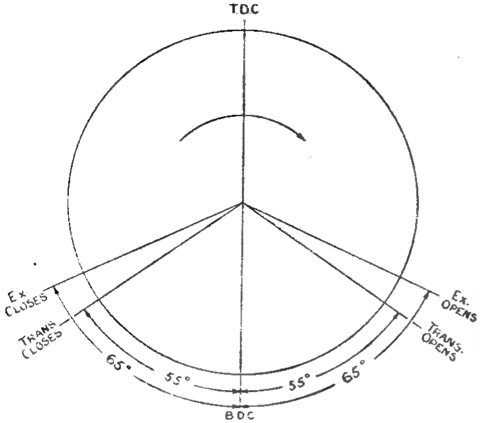


Fig. 8. Orthodox two-stroke timing

ment with deflector and cylinder-head design appears to be necessary if this is to be prevented. In the two piston designs where one piston is responsible for the transfer while the other piston takes care of the exhaust, it is an easy matter to upset the symmetry by advancing the exhaust controlling piston by a suitable amount. Using the timing given above, it was considered that a crankshaft displacement angle of 10 deg. would be adequate. This enables the exhaust port to be opened 20 deg. before the transfer port opens while they both close together. This displacement means that both pistons are not at top centre together but from previous experience a difference of $\pm$ 5 deg. in the ignition timing can be regarded as insignificant. Fig. 9 shows the individual timing of the transfer and exhaust ports, while a combination of the two is shown in Fig. 10. The out-of-phase angle of 10 deg. means that 36 teeth are required on the crank discs. This will enable the conventional symmetrical timing to be used, if necessary, to compare with the intended timing.

One difficulty which presented itself was the making of the cylinder-head joint. This would be easy if the cylinders were in one block, but with monoblock construction the provision of adequate transfer and exhaust passages would be very difficult. These could be secured to the outside of the cylinders by, say, brazing, and although ports brazed to cast-iron have been used by various constructors it is not a sound method, particularly where vibration is present. Clamped-on ports which have previously been used in two-stroke design were dismissed as not being satisfactory to use in the present case. If cylinder liners are used, which makes the cutting of transfer and exhaust passages in the cylinder block an easy operation, the joint cannot be made on the top end face of the liners due to the provision of a common combustion chamber being imperative.

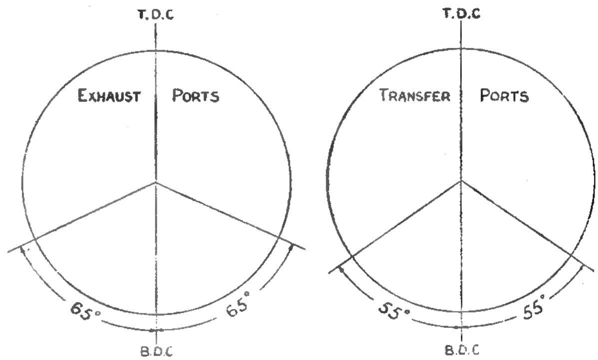


Fig. 9. Individual transfer and exhaust timing used for split-single

The difficulty was overcome by making a port belt for the two cylinders with ports coinciding with those in the liners. The liners each has a narrow flange which rests on the top of the port belt. Over the protruding portion of the liners is placed a second belt which is provided with cooling fins, the thickness of which is slightly greater than the upper portion of the cylinder liners. On top of this the cylinder-head made its joint. It will be seen that the joint on the liners is made at the flanges between the top of the port belt and the bottom of the finned belt. This necessitated having flanges of exactly the same depth but since the actual dimension is not critical this was easily carried out as described later.

A further advantage of this design is that a deflector on the piston is not required since the incoming gas is automatically directed up the transfer cylinder into the combustion chamber

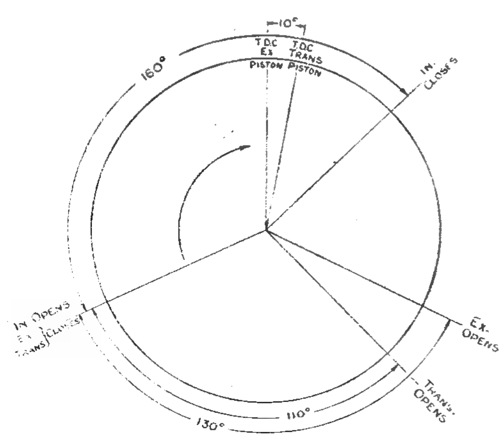
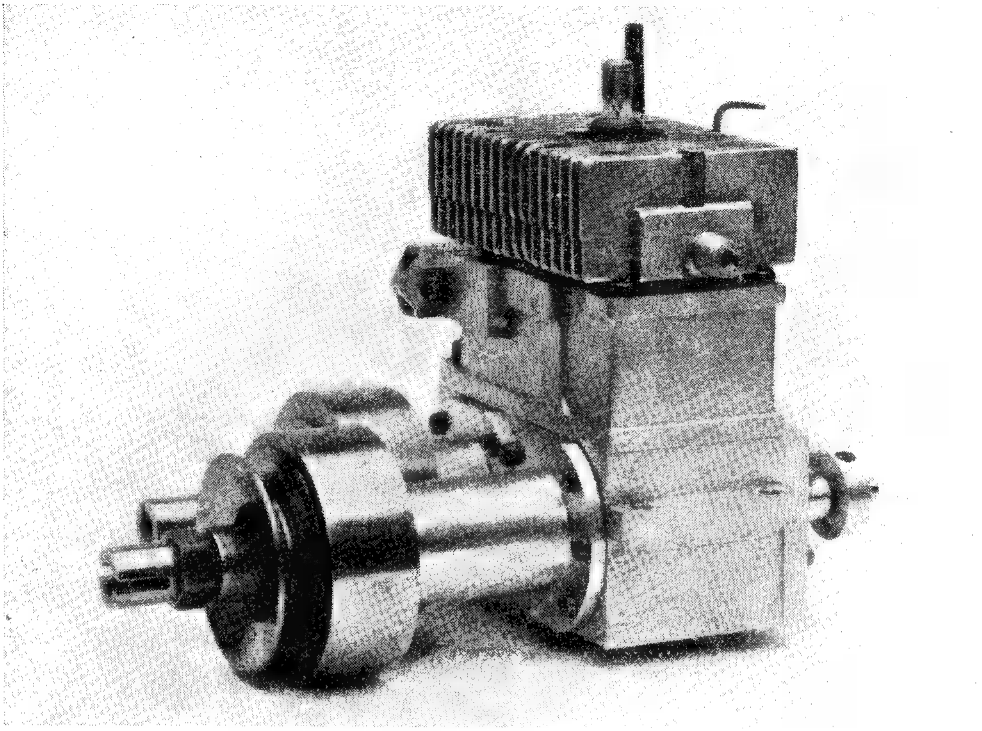


Fig. 10. Combined timings shown in Fig. 9 used for split-single

and down into the exhaust cylinder. In order to help the charge in the correct direction both the transfer and exhaust piston crowns are made conical, the angle of which is very obtuse. Further, there is no possibility of leakage from the transfer to the exhaust port around the piston

The rotary valves call for no comment except that they consist of mild-steel discs on nickel steel spindles which run in dural bearings. One of the rotary valve spindles extends beyond its bearing in order to take a coupling for a magneto drive. The usual 180 deg. induction period



An external view of the finished engine

skirt and the ports occupy the whole of the periphery of the liners except for a small portion where they are adjacent, there being no space available at this spot and it is an advantage to have the cylinder centres as close together as possible. The actual portion of the circumference used for ports is 90 per cent. Electron pistons are used, as in all previous designs to keep the reciprocating weight to a minimum. Two compression rings are fitted to each piston. Since these pistons have to be fitted with large expansion clearances the exhaust piston is fitted with a third ring at the bottom of its skirt to prevent leakage of the charge from the crankcase to the exhaust port.

It was rather a problem to decide on a suitable bore and stroke as obviously the centre distances of the cylinders determine the bore while the stroke is governed by crankshaft centres. Actually, to avoid too large a bore/stroke ratio, the cylinders were made desaxe to the extent of $\frac{1}{16}$ in. which E. T. Westbury has often recommended. The final dimensions arrived at were 0.740 in. bore by 0.700 in. stroke which gives a total displacement of 9.8 c.c.

was considered to be excessive in view of the fact that the transfer port closes rather later than the single-cylinder engines and thus was reduced to 160 deg. The opening of both valves takes place at the same time at which the transfer and exhaust valves close.

For a twin-screw boat the propeller shafts would not be parallel and an attempt was made to design the engine so that the crankshafts would be at the same angle as the propeller shafts, thereby avoiding the use of universal joints at the inboard end. This would entail the making of obtuse angle bevels for the synchronising gears and complicated angular bolting faces would also result. Also the rotary valves would be reduced in diameter. The straightforward method was adopted and two universal joints per shaft are used. In order to obtain a useful flywheel diameter it is necessary to stagger them one behind the other and provide crankshafts of different lengths to accommodate them. The flywheels, which are of mild-steel, are secured to the shafts by means of taper split collets, the female portion of the universal joint acting as a nut.

(To be continued)

*BALANCING SMALL ENGINES

Notes on basic principles and practical methods of procedure

by Edgar T. Westbury

BALANCING problems may sometimes (but not always) be simplified by the use of more than one cylinder. A very common arrangement consists of placing two cylinders alongside and parallel with each other, connecting the pistons of these cylinders to cranks disposed at 180 deg. as in Fig. 7. In practice, this is by no means a complete solution of the problem, because of the distance apart of the two cranks, with ■ corresponding offset in the plane of the pistons, which sets up ■ pronounced rocking couple. For an engine of given capacity, however, the pistons are smaller, so that the unbalanced forces are reduced in proportion, and another advantage (unconnected with balancing) is that the frequency of power impulses, at a given speed, is doubled, producing ■ more even torque at the shaft. The effect of the couple can be reduced to some extent by counterweighting the end crank throws.

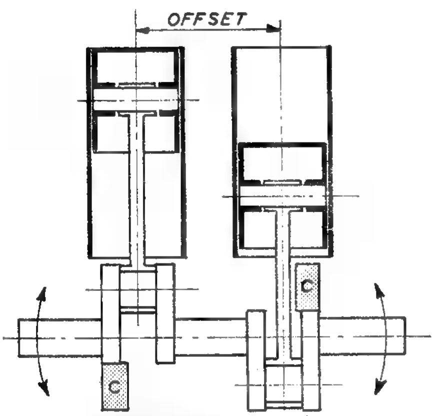


Fig. 7. *Twin-cylinder engine with cranks at* 180 *deg.*

In the attempt to reduce the offset in the plane of the pistons, the cylinders can be located on opposite sides of the crankshaft, as in the popular " flat twin," and use a two-throw crank so that the pistons move in opposite phase. It is not usually desirable in practice to place the two cylinders in exactly the same plane, so that there is usually ■ slight couple as shown in Fig. 8, but it is much less than in the side-by-side arrangement, and balance, on the whole, is fairly satisfactory. The same principle can be applied to any even number of cylinders, and " flat fours " and " flat sixes " have become increasingly popular in recent years.

Yet another arrangement for ■ twin-cylinder engine is to place the cylinders at right angles to each other, and connect the two pistons to ■ single crank throw, as shown in Fig. 9. The crankpin is counterweighted as for a single-cylinder engine, counterweight is always acting in direct opposition to one or other of the pistons, and therefore it is practicable to balance completely the reciprocating weight one one piston (the other being of exactly equal weight). Such an engine is very well balanced, but the arrangement has its disadvantages, particularly in petrol engines, as it introduces unequal firing intervals, unless the pairs of cylinders are multiplied, as in the " vee eight " now popular in motor cars. Note that the complete state of balance is only obtained when the cylinders are set exactly at 90 deg. ; the narrow-angle vee twin commonly employed in motor-cycles is not so good in this respect, being more of ■ compromise between the single and the two-crank twin. Radial engines having ■ symmetrical arrangement of cylinders may be

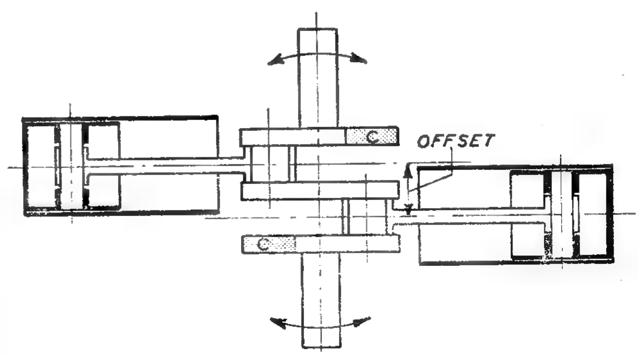


Fig. 8. *Horizontally-opposed two-crank engine balancing system*

*Continued from page 420, " M.E.," March 27, 1952.

balanced on the same principle as the 90 deg. vee twin, but it should be noted that when the rods do not all articulate on the crankpin centre, their order of motion is modified, and this may complicate balancing problems.

Side-by-side twins are often arranged with the pistons in the same phase, as shown in Fig. 10, the object being usually to obtain equal firing intervals, with smooth torque. From the balancing aspect, this may be considered a retrogression, as the problem is the same as that in a single-cylinder engine; but there is no doubt that the arrangement works well in practice, at least in engines of moderate cylinder capacity. The complete absence of a rocking couple, when the balance weights are symmetrically arranged relative to the reciprocating masses (which taken individually, are lower than those in a single of equal total capacity), is also a probable factor in the success of this type of engine. Sometimes a centre bearing is provided between the crank throws, but in other cases the space is occupied by an internal flywheel, which may be balanced in itself, or counterweighted to contribute to the partial cancellation of reciprocating forces.

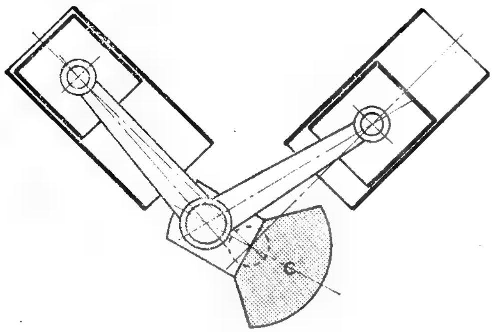


Fig. 9. Vee twin engine with cylinders at 90 deg., operating on a single crank

In the attempt to improve the balance of this type of engine, a centre crank throw is sometimes introduced, opposite in phase to the other two, and this is used to drive a charging pump or compressor, or even simply reciprocate a counterweight equal in moment of mass to that of the two main pistons. Split-single two-strokes, having two cylinder barrels with a common combustion head, sometimes have two separate crank throws slightly different in phase, and may have an opposed centre throw which drives a "displacer" to increase the volume of air displaced in the crankcase, thereby acting as a supercharger. An example of an engine of this type was the 15 c.c. engine of Mr. A. D. Rankine's *Oigh Alba Junior*, which unfortunately came to an untimely end in a fire at Kilmarnock some years ago.

Three-cylinder Engines

These have never been very popular in small or medium sizes, despite the fact that they can be arranged to give equal firing intervals in either two-stroke or four-stroke types. In a three-in-line engine with the cranks arranged as in Fig. 11, there is obviously a pronounced rocking couple which cannot easily be eliminated. Generally speaking, this arrangement is not well suited to high speed, but if it must be used, the best way is to treat each crank throw as a separate single-cylinder engine and counterweight the crank webs accordingly. Where it can conveniently be used, the radial arrangement of cylinders, acting on a single crank, is much to be preferred for high speed.

Four or More Cylinders

The orthodox four-in-line engine can be quite well balanced if the cranks are arranged in pairs at 180 deg., each pair being opposed to the other to cancel out the individual couples, as shown in Fig. 12. This arrangement is sometimes termed "mirror" balance, as each half of the engine resembles a reflection of the other as seen in a mirror. If the pistons and other working parts of such an engine are of uniform mass, the engine is capable of working smoothly, and with very little vibration. A similar arrangement can be used in a six-cylinder engine, with two opposed sets of three cranks at 120 deg., or eight cylinders, with two opposed sets of four cranks at 90 deg. It should, however, be noted that the stiffness of the crankshaft, and of the engine structure generally, has an important bearing on the success of such engines, as the cancelling of the two opposed couples has a tendency to bend the crankshaft in the middle.

The shorter and stiffer the complete engine structure can be made, the more likely it is to be successful in practice. This accounts for the decline in the popularity of the once-favoured

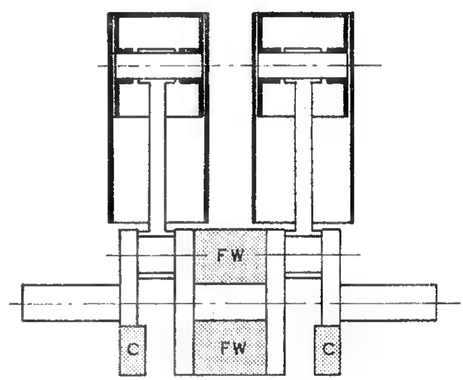


Fig. 10. Twin-cylinder engine with two cranks in phase

"straight sixes" and "straight eights," some of which were of prodigious length. It may here be appropriate to make some observations on the advisability of providing bearings between crank throws, as this matter has a pronounced influence on design from this aspect, and is often in dispute. Beyond doubt, it is a good thing to support the

crankshaft between crank throws, provided that the bearings are held rigidly in true alignment, and the shaft also remains true under working stresses. But these conditions cannot be guaranteed in practice in [redacted] engine which must be kept as light [redacted] possible for a given size ; moreover the provision of inter-throw bearings, if they are to be of any use at all, adds very considerably to the length of the engine, and therefore increases the effects of rocking couples. A further effect, not directly connected with balance, but capable of causing very troublesome vibration, is that of torsional deflection in a long and intermittently loaded shaft. As with many other things in engine design, [redacted] compromise is often necessary to get the best practical results from the most desirable features and avoid the worst of their disadvantages.

Primary and Secondary Balance

So far, I have dealt only with the means of dealing with the most important unbalanced forces in orthodox types of engines or machines ; and quite frankly, I believe that if these principles [redacted] fully grasped, they will cover most practical problems encountered by "M.E." readers. There are, however, other forces of the second, third and further orders, *ad infinitum*, but it would be impossible to do so without taking up a considerable amount of space, and going very deeply in theory and mathematics, which I feel sure would be out of place in a practical journal.

It may, however, be observed that secondary unbalanced forces occur in mechanisms where the motion is not truly harmonic, and this applies where a connecting-rod of limited length is used to link reciprocating and revolving parts. As short rods, involving considerable maximum angularity, are common in high-speed engines,

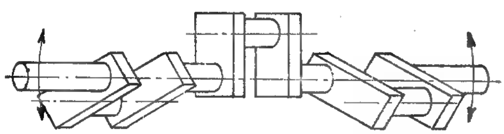


Fig. 11. *A three-throw crankshaft is subject to a pronounced rocking couple*

no simple system of balancing can eliminate these secondary forces completely, even in engines where the reciprocating masses can be directly opposed in identical planes. But [redacted] we have already seen, theoretical balancing systems do not always give the best results in practice, and again the importance of compromise must be stressed.

I have tried to assist readers to solve their own balancing problems in a strictly practical way, well knowing that nearly all model engineers are men of action, who would much rather spend their time at the lathe or bench than in working out theoretical problems on paper. I know from experience that these problems can be capable of purely practical solution, and I am not prepared to admit that this takes longer, or involves [redacted] labour, than the theoretical approach, always provided, of course, that basic principles are correctly grasped, and that one does not attempt to fly in the face of all physical laws.

There is much more that could be said about practical balancing problems, but I trust that

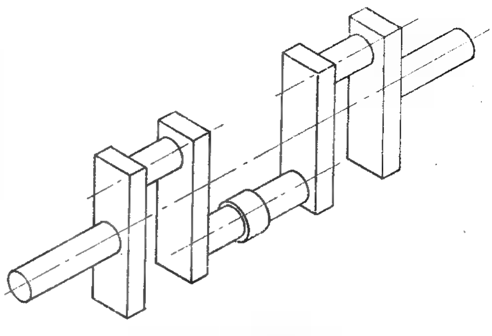


Fig. 12. *Normal arrangement of four-throw "mirror balanced" crankshaft*

readers will be able to apply this elementary, and admittedly limited, information to advantage, and be encouraged to work things out for themselves by practical experiment. The mechanisms dealt with here are those most likely to be encountered in model engineering, but unusual types of machines generally embody combinations of simple motions which can be isolated and analysed. Perfection in the balancing of any machine is rarely attained, but the higher the speed and the more exacting the duty, the closer must be the approach to perfection if the machine is to be [redacted] practical success.

Mild-Steel Bar Turning

Why do some operators of small lathes within the 3½ in. to 5 in. range consider they are taking "whopping" cuts when, e.g., they can start in towards the centre of [redacted] bar to a depth of ⅛ in., $\frac{3}{16}$ in. or ¼ in. according to size of machine ?

One writer mentioned on one occasion that with [redacted] 4 in. lathe he can reduce a bar of ¾ in. to nothing at 750 revs. by hand racking, and can do it quicker and get [redacted] better finish than by employing self-acting. Well, one has only to apply [redacted] glass on this assertion to see the irregular and uneven cutting lines as compared with the even distribution under power feed.

Of course, we are not told that the actual cut is equal to the thickness of a piece of paper, and can only be done by hand-feeding the leadscrew or racking, unless the power feed is fine enough to produce the same result.—"AXIAL."

Model Power Boat News

Transmission and Propeller Shaft Fittings

by " Meridian "

INSTALLATION of the power plant in the hull often presents difficulties to the uninitiated, especially, where the transmission is concerned. This is perhaps most marked in racing hydroplanes where an enormous amount of power can be lost by inefficient installation details.

The following notes, while primarily concerning hydroplanes, are, nevertheless, quite applicable to cruising boats of the launch type, especially where a high performance is the aim. Many well-known fast cruising boats use the outside " universal " for example, and there is simple type of coupling, as indicated in Fig. 1, is usual. It should be noted that screwed fittings are quite common with engines running anti-clockwise, as the torque tends to tighten them up. Good fitting threads are required, however, or when the engine stops, the inertia of the propeller and shaft may tend to unscrew the fittings.

For engines running clockwise; left-hand threads must be employed, or some alternative fixing, as shown, but in all cases the couplings must be robust enough for the power of the engine.

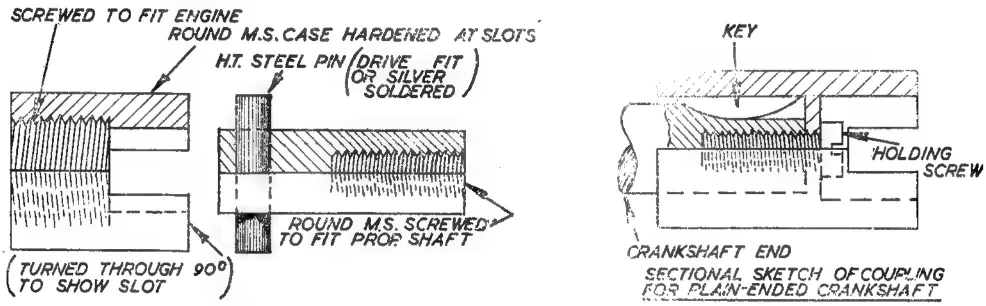


Fig. 1. Engine to shaft couplings

little doubt that the extra work involved making this is compensated by the ease of lining up and fitting the power plant.

Propeller Shafts, etc.

The material for the shaft is governed, in these times of metal shortage, with that which can be obtained, but as a guide, a good order of preference is: (1) High-tensile steel. (2) Stainless-steel. (3) Silver-steel. (4) Mild-steel. For the various classes of racing boats the following minimum sizes are desirable. Class " A " 7/32 in. diameter; Class " B " $\frac{3}{16}$ in. diameter; Class " C " 5/32 in. diameter. If stainless-steel is used, care is necessary in selection, as certain grades may prove to be rather soft and easily distorted.

With some engines now developing full power at around 15,000 r.p.m., it is essential that long lengths of the shaft are not left unsupported, otherwise the shaft may whip and cause severe damage to the hull!

There is no need to use long bearings for support. An easy-fitting bearing of $\frac{1}{8}$ in. thick Tufnol has proved adequate, and has very little friction.

Regarding the drive from engine to shaft, a

Most engines are lined up with the crankshaft parallel with the propeller shaft, but if it is desired to keep the engine level, a universal joint of similar type to that used on the propeller bracket is required. Generally speaking the engine couplings require to be of heavier construction than the outside " universal," since breakages seem to be more prone to occur at the engine end. This is probably due to the " torsion-rod " effect of the propeller shaft, which may cushion the outside universal to a certain extent.

For drive pins, high-tensile steel is recommended, and a good source of this material for the purpose is heavy gauge motor-cycle spokes. There is also the alternative of turning down high-tensile steel bolts for items of transmission gear. Some of the Government surplus stores have had stocks of high-tensile bolts from time to time, and it is well worth while obtaining some for the steel.

Drive pins will need to be fairly stout, especially for the larger boats, and at the engine coupling pins of less than 5/32 in. diameter may give rise to trouble if the engine is really powerful.

Universal Joints

Practically all the present-day racing boats

use the " ball and pin " type of joint, and as this design has proved to be efficient and easy to make, it is not proposed to describe any of the alternative types that have been used in the past.

Since the advent of the surfacing propeller, universal joints work at a much more gentle angle than in former times, when the need to submerge fully a propeller of perhaps over 3 in. diameter, sometimes called for an alarming angle between the propeller-shaft and tailshaft. This modern development is all to the good, and it is almost certain that hardly any power is lost in a really well-fitted universal joint.

Fig. 2 shows a typical ball and pin type joint, together with the tailshaft. The female half of the joint is simple and straightforward, but it is suggested that the final turning operations are done after securing to the propeller shaft, so that it will run truly when finally fitted in position. The slotted end may be case-hardened in order to prevent undue wear, but care is necessary during this process that the heating is confined to the end, or the silver-solder may melt at the propeller shaft joint.

The " ball " of the universal may either be turned in one with the tailshaft (made preferably from high-tensile steel), or it can be fabricated with the aid of an ordinary steel ball as used in ball-bearings. Soften the ball by heating to red heat and allowing to cool ; the ball is then held in the lathe chuck and centred. A small pilot drill is used first, then followed by a drill about 1/64 in. smaller than the tailshaft size.

It is surprising how firmly most 3-jaw chucks will grip the ball, but in order to ensure that it is drilled accurately a piece of really true silver-steel of the same diameter should be gripped first and checked for rotation, if it *is* out of truth, note which jaw requires packing with a shim, and use this when gripping the ball.

The tailshaft is reduced in diameter at one end to fit the hole in the ball. A slightly easy fit—say not more than 2-thou., is desirable so that the silver-solder really floods through the joint.

Drilling the cross pin-hole is another operation that requires care, but it can be accomplished in the lathe, holding the drill in the lathe chuck and supporting the ball on a piece of tube smaller on the inside diameter. The tube is held in the tailstock chuck with the tailshaft held firmly by hand. So that a hole exactly at right-angles can be drilled, the tube may require to be filed at one point to clear the tailshaft where it joins the ball.

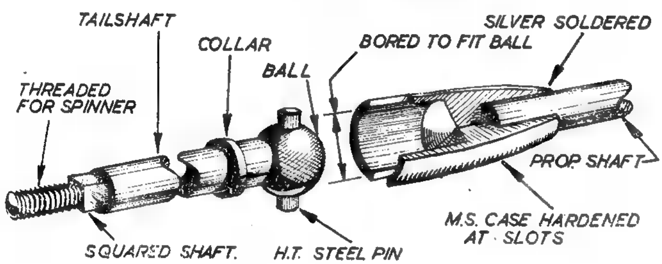


Fig. 2. Ball and pin universal joint

An alternative method is, of course, to set up the tailshaft accurately on a fixture or vertical-slide mounted on the lathe cross-slide.

Cross-pins can be made either fixed or floating, the latter being, perhaps, the better job. If a fixed pin is decided upon, the ball is simply drilled for the cross-pin, which is then made a drive fit. For the floating pin, the ball must be drilled and reamered to take an accurately finished pin. Flats are filed on the working faces of the pin to fit the slots in the other half of the universal. When assembled in working position, the pin cannot fall out because of the shoulders formed on the pin by the filing process.

Tailshafts

The tailshaft will require to be slightly larger in diameter than the propeller shaft, and the following sizes are suggested—Class " A," $\frac{1}{4}$ in. diameter ; Class " B " 7/32 in. diameter ; Class " C " $\frac{3}{16}$ in. diameter.

In order to prevent the universal joint fouling the skeg bearing, it is necessary to fit a collar, or if the tailshaft is turned from a larger piece of material it can be turned at the same setting as the ball. This collar must be at such a distance from the ball so as to allow the universal a little endwise play when the slots are fully engaged with the cross-pin.

The tailshaft should not be weakened by drilling at any point, so it is suggested that if the collar is separate, it is either a drive fit or silver-soldered to the shaft.

Many different methods of fixing propellers have been used, but it is essential that the method adopted is positive and does not weaken the tailshaft unduly. The screwed-on propeller has been used with some success, but it is somewhat difficult to get the correct clearance end-ways, or perhaps over-tightening and seizing of the tailshaft may occur.

Fig. 2 shows the method suggested. The shaft is squared for a short distance and this square takes the drive. The propeller boss is a good fit on the round part of the shaft, but the hole is not continued right through. About $\frac{1}{8}$ in. from the rear end the hole is reduced in size and squared to fit the tailshaft.

The advantage of this type of fitting is that the propeller is held truly by the round part of the shaft, the square only taking the drive. A streamlined spinner is fitted on the threaded end of the shaft and holds the propeller against the shoulders formed by squaring the shaft. A thrust washer is fitted immediately behind the propeller, and when finally assembled, only a little end play should be allowed.

Propeller Brackets

There are two main types of propeller bracket or " skeg "—floor fixing and transome fixing. The former is the most generally used, and is lighter and stronger, especially since surface propellers only require about $\frac{3}{4}$ in. from the floor

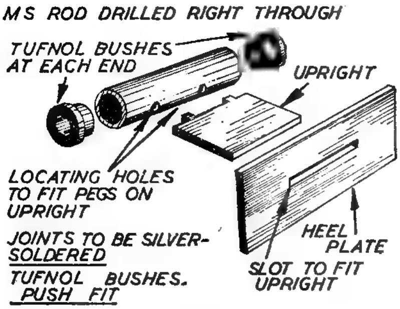


Fig. 3. *Sketch showing method of making propeller brackets*

of the hull to tailshaft centre. Fig. 3 shows a method of fabricating a skeg, and the photograph shows one of this type together with a pattern and casting in aluminium.

Mild-steel is quite suitable, the flat material can be $\frac{1}{8}$ in. thick, provided the edges are chamfered off well and generally " streamlined." When silver-soldering together, a nice fillet should be made at both joints.

Tufnol bushes are recommended for the bearings, the rear one also taking the thrust. Water is a natural lubricant for tufnol, and several well-known speed boat exponents have reported no improvement using a small ball-race instead of the tufnol bearing. The thrust washer used with the tufnol should be flat and preferably hardened. The best method of securing the skeg is by countersunk steel bolts right through the hull. A reinforcing piece of $\frac{1}{4}$ in. hardwood will be necessary inside the hull, and a bracketing-piece located centrally to tie the transome to the floor is also a help. Wood screws are best avoided here, as they will work loose sooner or later.

Stern Tubes

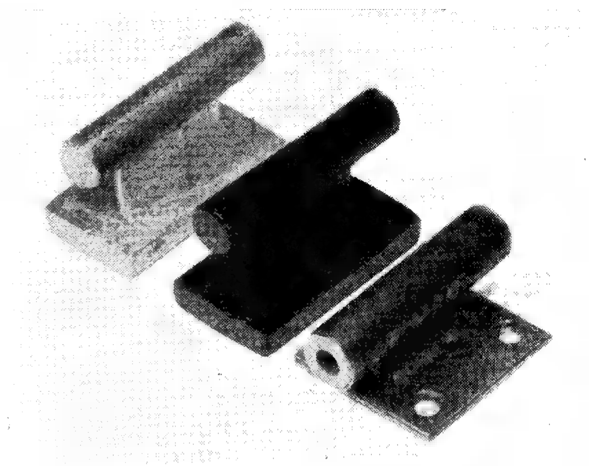
Getting the propeller shaft through the floor of the hull in a neat manner is often a problem for beginners. For simplicity and general facility of doing the job, the following methods are suggested : Temporarily fix the engine to its bearers and the propeller bracket to the hull in its final position.

Carefully find the place where the shaft will break through the hull floor. Now cut a slot in the floor of the hull, and try the shaft in position. Allowance must be made for the diameter of the stern tube, which should be of light gauge brass or steel tube. The propeller shaft must have clearance through the tube, except at one end where a short bush gives a bearing to the shaft. There is no need to make the tube longer than is necessary to span the slot in the hull floor.

The latter (especially if of thin plywood) should be reinforced with some $\frac{1}{8}$ in. ply on the inside, covering the area of the slot.

A metal heelplate should be made for the outside of the hull : thin brass is suitable for this item, and it should be drilled with fixing holes about $\frac{3}{4}$ in. apart all round.

Now the shaft, together with the heelplate and sterntube, are assembled in the hull again. (The engine and skeg *must* be fitted in the correct positions.) Screw the heelplate down with several screws, and using a hefty soldering iron, soft-solder the tube to the heelplate, while accurately lined up. The heelplate and tube can now be removed if desired for cleaning up, but when finally fitting, " plastic wood " can be used to level off the floor of the hull on the inside.



Examples of propeller brackets made by Mr. N. Hodges (Orpington). Left to right : Casting, pattern and fabricated bracket

An oil cup for lubricating the bearing of the stern tube is desirable and in the case of cruising boats, *two* bearings, one at each end, are necessary, and the tube packed with grease. The stern tube can be brought up almost to the engine coupling, since weight is not a serious problem in free-running craft. Leakage of water past the tube does not matter much in hydroplanes, which, of course, run with their rear plane clear of the water.

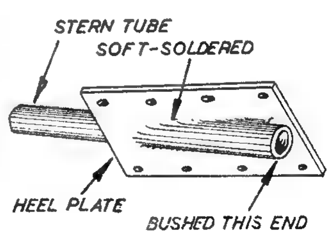


Fig. 4. *Sketch showing stern tube and heelplate*

Miniature Locomotive Performance

Comments upon information which has been sent in from various sources

Photo by] [*C. B. Leighton*
Mr. R. Coffin couples up " 1188 " at the South London Locomotive Trials

DURING the past twelve months or so, there have been indications that the actual performance of miniature steam locomotives working under track conditions is attracting the attention of enthusiasts to a greater extent than before. The idea of staging systematic tests is beginning to gain ground, and there can be no doubt that the results of these tests will, in time, prove to be useful; but we think that to endeavour to make an exact science of miniature steam locomotive design, with the sole object of attaining a sort of standard maximum economy of performance, would be a mistake. Such an ideal, even if it were agreed upon for general adoption, would rob the hobby of more than half its interest. However, we do not see much prospect of that, just yet!

On the other hand, there is plenty of evidence to suggest that the performance of many miniature locomotives is not so good as it might be; but the big question which, so far, remains so difficult to answer is: Why? Only by collecting and comparing information obtained directly from the locomotives themselves will it be possible, in time, to suggest a line of inquiry into the effects of certain features of design, or of driving, or of anything else that is likely to have some influence upon the running of a miniature locomotive.

Perhaps, the most astonishing of the results so far to hand was the winning of the South London Club's 1951 trials. The winner was not a gigantic multi-coupled, multi-cylindered engine of " modern " type, but none other than Mr. A. J. Maxwell's 5-in. gauge replica of an old-time G.W.R. 0-6-0, No. 1188. This was not a case of just " scraping through," but of definite superiority over all other competitors; the score was 288 points, as compared with 271 points for second place and 264 for the third. The others were well behind.

A comparison of the particulars of the three engines concerned is of interest:—

First, Mr. Maxwell's " 1188 "; gauge, 5 in.; wheel arrangement, 0-6-0; two cylinders, 1⅜-in. bore by 2⅛-in. stroke; boiler pressure, 70 lb. per sq. in.; wheel diameter, 5¼ in.; tractive effort 53.3 lb.; load hauled, 1,120 lb.; time, 10 min. 4.8 sec. Driver, R. Coffin.

Second, Mr. W. R. Cook's *Ida*; gauge 3½ in.; wheel arrangement, 0-6-0; two cylinders, 1½-in. bore by 1½-in. stroke; boiler pressure, 60 lb. per sq. in.; wheel diameter, 3¾ in.; tractive effort 30.3 lb.; load hauled, 480 lb.; time, 7 min. 9.6 sec. Driver, H. J. Philpotts.

Third, Mr. Tom Rowland's *Smeaton*; gauge 3½ in.; wheel arrangement, 4-6-2; two cylinders, 1⅛ in. bore by 1⅝-in. stroke; boiler pressure 90 lb. per sq. in.; wheel diameter, 4⅞ in.; tractive effort 38 lb.; load hauled, 640 lb.; time, 7 min. 25 sec. Driver, Tom Rowland.

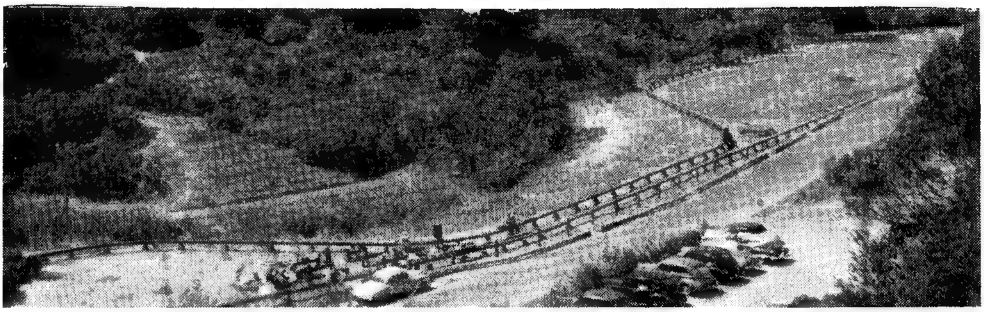
The track was a straight length of 130 ft., and each engine had to run twenty " laps " of one down and one up. The formula used for calculating the scores was:—

Total load in lb. multiplied by the distance covered (number of complete journeys) and divided by the theoretical tractive effort.

This formula has the merit of simplicity, and its use leads to results which appear to be satis-

factory, since the factors of which it is made up are those directly affecting the performance of the engine.

A rather different approach to the matter is revealed in ■■ interesting letter we have received from Mr. V. T. Shattock, of the Golden Gate Live Steamers, California, U.S.A. Here again, is ■ very striking instance of ■ small, light, old-time engine giving ■ performance which is, on the face of it, markedly superior to that of a larger and more modern design. This was not an official test, but just ■ friendly contest between two widely contrasting miniature locomotives on a 1,331-ft. continuous track. The two engines were: Mr. Walter Brown's beautiful old-time 4-4-0, "999," illustrated and described in THE MODEL ENGINEER for October 18th, last, and Mr. Shattock's 4-6-2 engine.



A general view of the Golden Gate Live Steamers' track, Redwood Park, Oakland, California

Each engine was, of course, sole occupant of the track when on test, and each was given ■ preliminary run round the track to make sure that everything, such as pumps, lubricators, etc. worked properly. Then the fuel and water tanks were filled and the test run started; both engines achieved ■ 14-lap non-stop run, a distance of just over three and a half actual miles. At the end of the run, Mr. Brown's "999" had ■ little water left in the tank, but not enough to enable her to run another lap; Mr. Shattock's engine had used all her water.

A comparison of the two engines may be of interest, so here are the particulars :—

	"999" 4-4-0	Pacific 4-6-2
Cylinder ..	$\frac{7}{8}$ in. × $1\frac{1}{8}$ in.	$\frac{7}{8}$ in. × $1\frac{3}{16}$ in.
Valves ..	Piston (long travel)	Piston
Gear ..	Stephenson's	Walschaert's
Drivers ..	4, $3\frac{9}{16}$ in. dia.	6, $3\frac{3}{8}$ in. dia.
Fuel capacity	$1\frac{3}{4}$ pints	$1\frac{3}{4}$ pints
Water ,,	2/5 U.S. gal.	$\frac{3}{4}$ U.S. gal.
Load in addition to car	200 lb.	167 lb.
Time ..	40 min.	39 min.

Commenting on these runs, Mr. Shattock writes: "An analysis of the performances indicates, in my opinion, that Walter's engine was far more efficient than mine for the reason that he used much less water and hauled a heavier load for the same distance. Each engine had fuel to spare when the test was complete, however; we had no means of measuring the amount used, other than the knowledge that the consumption for each locomotive did not exceed $1\frac{3}{4}$ pints.

"Walter and I both agree that learning to drive the locomotives will give us both better results. In the case of my driving on this occasion, I did not keep up a good fire for a great portion of the distance, due mainly to dirt in the fuel line having collected around the fuel control-valve which slowed down the fuel supply to the burner. Every once in a while, I would manage to open and close the valve and release the stoppage, permitting the fire to increase to normal. Immediately, the engine would speed up, not because of any increased pressure, but for the reason the heat became applied to the superheater elements. In other words, I had run ■ great part of the course with low pressure due to low fire, and consequent low superheat. I feel that I can bring about better results by making sure of having ■ good fire, higher pressure and consequent higher superheat to the steam going to the cylinders.

"I am hopeful that other members of our fraternity in the U.S. will take part in similar tests; in addition to making the hobby more interesting it is one way of learning more about what it takes to make a little steam locomotive do what is expected of it."

The results of these observations are very interesting; if we knew the weight of the car and the working pressure of Mr. Shattock's Pacific, we could have applied the South London Club's formula and discovered which of the American engines really won the contest! Or, should we? From the figures in the table, "999" seems to be not only the better performer but also the more efficient engine of the two; but we would be most interested to learn the result of a similar contest between the two when the Pacific is running with ■ clear fire.

To revert to the South London results, there is one other small point which seems worthy of attention, though it is not specifically mentioned in the results. It is that the ratio of load to tractive effort was, in round figures, 22 for the winner, 16 for the second and 17 for the third. For full-size locomotives, this figure usually lies somewhere between 20 and 30 in ordinary traffic conditions.

Building a Pulley
for a Triple V-Belt Drive
by "Duplex"

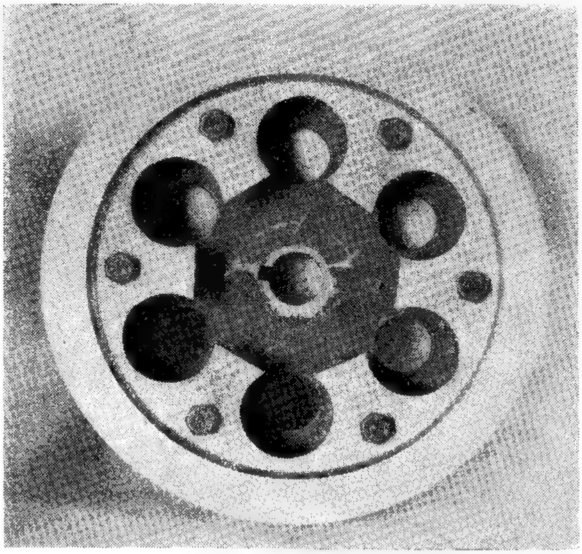


Fig. 1. The two pulleys bolted together

A FRIEND, who was installing an air compressor for spray painting, recently sought our advice as to the best form of drive from the 1 h.p. electric motor used as the power source.

The advantages of a short, V-belt drive for this purpose were fully appreciated, and these include the good frictional grip obtained, as well as quietness of running combined with long and trouble-free belt life. As the driving strain is intermittent and rises to a peak when the piston reaches the top of its stroke, the cushioning effect of the belt drive is also of some value.

The compressor was fitted with a 9 in. diameter, single groove, V-pulley, and when the machine was run it was found that belt slip occurred on the compression stroke as the maximum working pressure was reached in the air container; furthermore, this fault could not be cured by merely over-tightening the belt.

Clearly, this kind of slip, besides lowering the efficiency of the drive, is almost certain to shorten the life of the belt itself; moreover, excessive tensioning of the belt may cause undue wear in the shaft bearings of both the motor and the compressor.

It seemed, therefore, that the best way out of the difficulty was to fit a multiple belt drive to increase the frictional grip, and, at the same time, this would allow rather smaller belts to be used, with the added advantage that the thinner and more flexible belts would absorb less power in being bent round the pulleys. Accordingly, it was decided to fit three V-belts running side by side in pulleys of corresponding form.

The actual single-groove pulley supplied with the compressor was secured to the crankshaft of the machine by means of a key and grub-screw, and in addition a clamp-nut was fitted to the end of the shaft. As the length of the pulley's hub was equal to the length of the seating provided on the crankshaft that is to say, $1\frac{1}{2}$ in., there was no robm to mount a second, two-groove pulley in the same way. As the method of attachment of the single pulley had been designed to take the

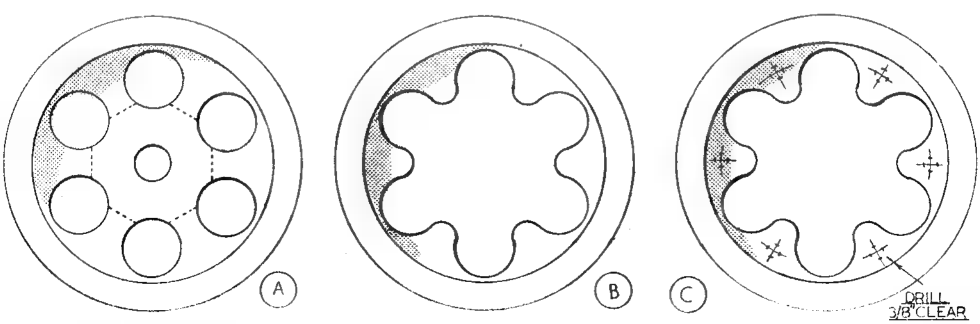


Fig. 2. Adapting the additional two-groove pulley. "A"—hacksaw through the arms to remove the hub; "B"—round off the arms; "C"—mark-out the bolt holes

full driving load, there seemed no reason why the additional pulley should not be attached to the first, and as the driving strain was taken at the pulley rim, the nearer to the periphery the coupling was made, the better.

No Projections

The hub of the second pulley was not, therefore, used to take the drive, and as it merely obstructed the fitting of the crankshaft clamp-nut, it was cut away with a hacksaw, as represented in Fig. 2A. It was thought best at the time not to remove too much of the pulley arms, for these might be needed later if it was found that additional fixings were required to transmit the drive. However, it is important not to leave any projections that might catch in the clothing when the machine is working, and so the free ends of the arms should be rounded off, as shown in Fig. 2B. An even safer way of finishing the work is to fit a sheet metal disc to the outer pulley, as is sometimes done to the wheels of motor cars. The pitch circles of the holes for the six clamping bolts can quite easily be marked-out by using the surface gauge with its base register pegs pushed out so as to make contact with the rim of the pulley, and with the scriber set to make contact with the surface of the casting.

Trial and Error

A punch mark is next made on the pitch circle at the centre of one of the arms, and the dividers are adjusted by a process of trial and error until they are found to span the circle in six equal steps. The bolt centres, found in this way, are then centre punched, centre drilled, and finally drilled 25/64 in. to give clearance for the $\frac{3}{8}$ in. diameter clamping bolts.

Another way of marking-out the bolt holes is to mount the two pulleys, in turn, on a mandrel gripped in the lathe chuck; the pitch circles are then scribed with a V-tool held in the lathe tool-post. When this method is adopted, the bolt holes can also be indexed from a change wheel mounted on the tail of the mandrel; a wheel divisible by six is selected, and a detent is used to engage the teeth. If preferred, one pulley can be marked-out and drilled so that it can be used as a drilling guide for the second; for this purpose, the two pulleys can be centred by mounting them on a common mandrel fitting the hub bore, and the two rims are held together by means of a pair of toolmaker's clamps.

Two forms of clamp bolts are illustrated in Fig.3, and it may save material if a length of threaded rod is used instead of a standard bolt. The method of assembling the two pulleys is shown in Fig. 4, and it will be seen that the stud or bolt is first secured in the inner, single-groove pulley; a second nut is then put on the projecting stud. Next, the second pulley is slipped on to the studs and lightly bolted in place by means of the nuts on the outer side. At this stage, it is advisable to make sure that the two pulleys are correctly centred so that they will run truly when finally fitted in place on the compressor.

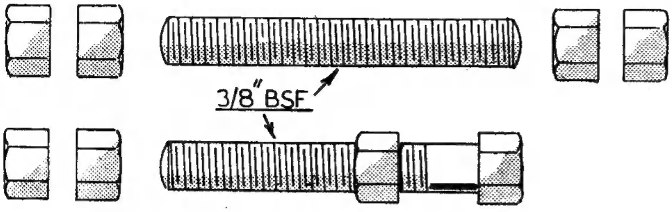


Fig. 3. Either a stud or a standard bolt is used for clamping the pulleys

The work can be checked by again mounting the assembly in the lathe, and any lack of true running can then be corrected by tapping very lightly with a mallet on the rim of the second pulley.

If the pulleys cannot be mounted in the lathe, the centring can be checked by applying a small try-square to the rim, so as to bridge the tops of all three grooves at four equidistant points on the circumference. When all has been found in order, the outer nuts are evenly, but lightly, tightened, and the nuts on the inner side of the second pulley are then firmly secured. In this way, the side faces of both pulleys are pressed closely together, but the nuts on the inner side act as distance-pieces and do not allow the pulleys to be distorted by the clamping pressure.

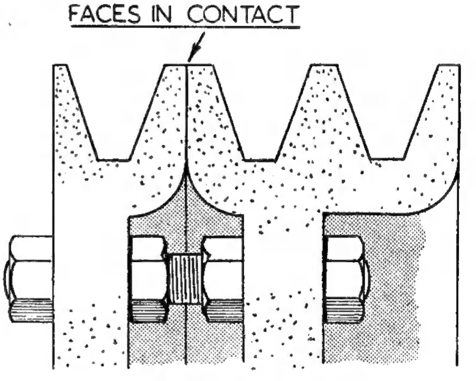


Fig. 4. Showing the method of assembly

It might be thought that it would be easier to use solid distance-pieces for assembling the pulleys, but the contact surfaces are unmachined and each distance-piece would, therefore, have to be separately adjusted for length to get an even bearing; to machine or spot-face these surfaces would involve an unnecessary amount of labour.

Queries and Replies

Enquiries from readers, either on technical matters connected with model engineering, or referring to supplies or trade services, are dealt with in this department. Each letter must be accompanied by a stamped, addressed envelope, and addressed: "Queries Dept.," THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2.

Queries of a practical character, within the scope of this journal, and capable of being dealt with in a brief reply, will be answered free of charge.

More involved technical queries, requiring special investigation or research, will be dealt with according to their general interest to readers, possibly by a short explanatory article in an early issue. In some cases the letters may be published, inviting the assistance of other readers.

Where the technical information required involves the services of an outside specialist or consultant, a fee may be charged depending upon the time and trouble involved. The amount estimated will be quoted before dealing with the query.

Only one general subject can be dealt with in a single query; but subdivision of its details into not more than five separate questions is permissible. In no case can purely hypothetical queries, such as examination questions, be considered as within the scope of this service.

No. 9940.—Steel Tempering
A.B. (Canterbury)

Q.—In various instructions relating to the tempering of steel, one is told, simply, "heat to *X* degrees Fahrenheit, etc." How can the average model engineer assess these temperatures with reasonable accuracy?

R.—The temperatures to which steel is heated for tempering can be judged with a fair measure of accuracy by observing the colour of the film of oxide which forms on the surface of the object being heated. The following table will serve as a guide for all practical purposes :—

Small tools requiring keen cutting edges: 480 deg.—Pale yellow.
Surgical instruments, razors, etc.: 446 deg.—Straw yellow.
Taps, reamers, penknives, hammers, etc.: 469 deg.—Golden yellow.
Scissors, garden shears: 491 deg.—Brown.
Planes, axes, etc.: 509 deg.—Brown, purple spots.
Wood-turning tools, table knives, cold chisels: 531 deg.—Purple.
Swords, watch springs: 550 deg.—Bright blue.
Augers, fine saws, etc.: 559 deg.—Full blue.
Hand saws, etc.: 600 deg.—Dark blue.

No. 9944.—Truing-up Crankshaft Journals
A.S.H. (Banstead)

Q.—Can you advise me of a method of truing-up crankshaft big-end journals of a stationary engine, without removing the shaft? The shaft is slightly ridged, and oval some 2 thous., and it is thought that some kind of lap might be clamped on it and worked round by hand. The clamp would have to be in two pieces in order to get it on. The diameter concerned is about $1\frac{5}{8}$ in. and it would be rather like removing the sump of a car and working on the engine shaft underneath.

R.—It is practicable to true up crankshafts or other shafts which cannot readily be mounted in a lathe, by means of a suitable form of hand tool. The idea of lapping, as you suggest, is quite practicable, but comparatively slow. We would suggest that a lap might possibly be improvised from a motor car connecting-rod, with split big-end bearing, which could be bushed with copper or soft aluminium and charged with abrasive material to form a lap. It is also quite possible to mount a cutting tool in this way in cases where larger quantities of metal have to be removed. Some years ago, a tool specially for the purpose of truing-up the big-end bearings of motor cars was available on the market, but we cannot say whether it is still made.

No. 9935.—Connecting a Transformer
F.R.T. (Newport)

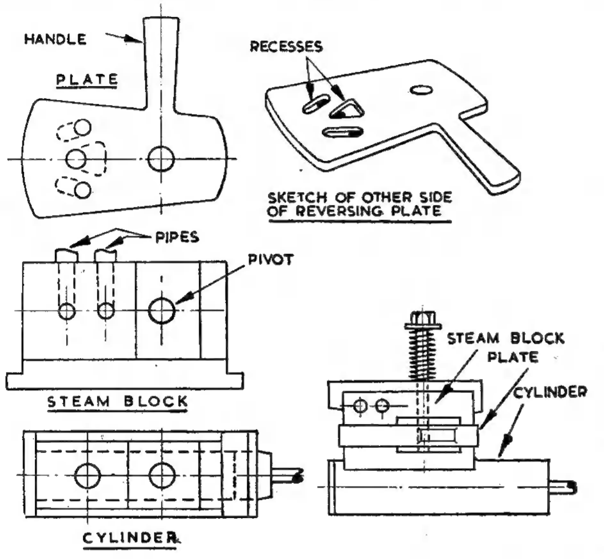
Q.—I have several 24 V and 12 V motors suitable for driving models including a 5 in., 12 V, C.A.V. dynamo which I wish to use as a motor. Can you tell me how to connect up a transformer to give 15 V, a.c., 10 A; also, how to test. I have two P.C.A. Manufacturing Company's transformers and would like to connect both to get 24 V, after being rectified. What amperage can I expect?

R.—The amount of amps. the transformer can supply will depend upon the respective secondaries so far as wire size is concerned. Before connections can be determined, it is necessary to have access to a suitable voltmeter. By the use of this meter it will be possible to test the connections that are possible. The 10 and 5 V range can be connected in series for example; to do this, the respective inner and outer ends of the windings must be known, and this may not be possible. However, connect the two windings in series and see what the meter shows; if it reads 15 V it is in order, but if the reading is lower, simply reverse the ends of one coil only. This refers to the other secondaries. The low voltage secondaries will give a voltage of 7.5 when connected in series, and from this it would appear that the only winding that can be used is the 10-5 range.

No. 9942.—Reversing Gear for Oscillating Engines
E.A. (Southampton)

Q.—I would be grateful if you could give me any information on reversing gear for single-cylinder oscillating engines.

R.—The usual method of reversing single-cylinder oscillating engines is to use a form of reversing valve which interchanges the steam and exhaust connections to the port block, on which the cylinder oscillates. A simple four-way plug cock can be arranged to do this, but it is also possible to incorporate the reversing device in



the port plate itself, and we give herewith sketches showing how this can be accomplished. It will, of course, be appreciated that all the working faces, including both sides of the reversing plates, the port plate and the cylinder face, must be dead flat and very highly finished to avoid steam leakage, between the surfaces.

No. 9950.—Motor Connections
A.J.H. (Pontefract)

Q.—I would be glad of your advice regarding the connections of a 230 V single-phase motor having four poles and four brushes. Anti-clockwise rotation viewed from bushes end.

R.—Your motor will be either a repulsion or repulsion-induction motor. If it is of the repulsion-induction type, the brushes will leave the commutator when the motor reaches a certain speed. If repulsion, the brushes remain on the comm. all the time. The motor may have two or four leads at the terminal block. Where four leads are provided, the motor will be wound for two voltages; the connections being in series for the high voltage and in parallel for the lower voltage. The motor is connected direct to the supply from these leads and no special switch is necessary.

No. 9947.—Piston Clearances
J.F.H. (W.2)

Q.—I have recently completed the 5 c.c. Kestrel engine and am very satisfied with the result. I have one spot of bother, however, and that is a persistent tendency to tighten up after about 40 sec. running, even with an excessive amount of oil in the fuel, and an air-blast on the cylinder. Could you give me any idea of piston clearances? Examination of the piston shows no sign of a high spot. The piston is a casting from Mr. L. D. Johnson and is fitted with rings.

R.—It is always very difficult to specify this definitely, as various alloys have different degrees of expansion. In the case of the castings produced by Mr. Johnson, the rate of expansion should be quite low, and comparatively small clearances should be possible. A tightening up of the piston, after a short run in the initial stages, will do no harm, provided lubrication is always present, and assuming that no definite high spots are visible. We suggest giving the engine a number of runs in short bursts with plenty of oil in the fuel, until the piston wears to the correct clearances. It is possible to increase piston clearance when rings are used, but generally speaking, a piston which is fitted with sufficient clearances to run without any tendency to tighten up in the initial stages will be found to be very slack after the engine has been in use for some time.

No. 9948.—Tachometers
F.L. (Gosport)

Q.—I have scanned the advertisement columns of THE MODEL ENGINEER for a small tachometer, to give r.p.m. up to, say, 5 to 10 thousands. I am experimenting with small steam turbines, shaft size $\frac{1}{8}$ in. to $\frac{3}{16}$ in., and require a small light revolution indicator for same. Many of the *ex*-Government instruments are too heavy to drive .Could you please advise me as to where I may be able to purchase a likely tachometer?

R.—There are several types of small tachometers on the market, but most of them are rather expensive. The type that we have found to be most satisfactory for use on very small engines is that made by Messrs. Smiths (Motor Accessories) Ltd., Cricklewood, N.W.4.

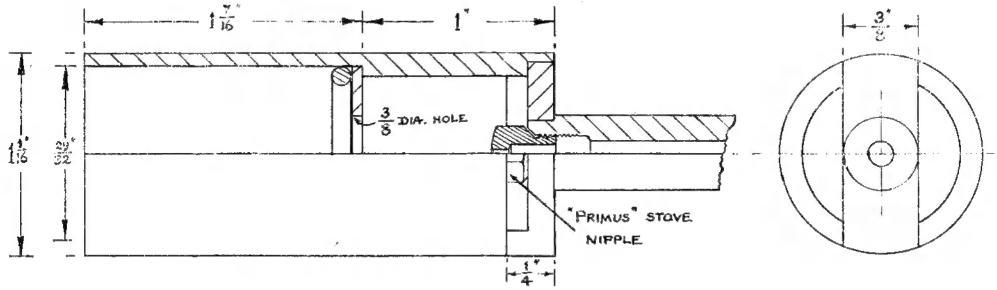
We may add that the most reliable method of recording exact revolutions per minute of small engines is by means of a counter, such as one of the Veeder type, which can be driven at reduced speed through a worm or other reduction gearing.

On a very small engine with little power available, the counter may be geared down as much as 1,000 : 1, and the time taken to click over either 1, 10 or 100 on the counter may be checked accurately by means of a stop-watch. This is the accepted method in laboratory practice, as all types of tachometers are subject to inaccuracy under certain conditions, and are not regarded as perfectly reliable for exact tests.

PRACTICAL LETTERS

A Calor Gas Torch

DEAR SIR,—Having been much interested in the recent article by "Duplex" on equipment for use with Calor gas, it occurred to me that some of your readers might also be interested in the burner, as seen in the sketch. This is designed for connection direct to the cylinder of gas (at 20-25 lb./sq. in.) avoiding the expense of the high pressure reducing valve. It is true that used in this way the working pressure varies slightly with the temperature, but I have not found this to cause any inconvenience in practice. An acknowledgment is perhaps due to the British Oxygen Company, on whose self-blowing acetylene brazing torches the design is based in principle.



The body of the burner was made from a scrap of ¾ in. iron pipe skimmed up outside and bored for the baffle plate, which is a ⅜ in. washer held in place by a circlip of piano wire. The jet end was made by brazing in a disc of steel carrying the feed tube, after which the air inlets were sawn out. The jet is a "Primus" stove nipple the bore of which is about 0.014 in. A union (not shown) attaches the burner to a handle in which is a small needle valve; this connected by synthetic rubber hose to a stop-valve on the side arm of a special tee-piece made to fit between the Calor gas cylinder and the normal low pressure reducing valve feeding other appliances of orthodox design.

I have no means of measuring the burner's gas consumption, nor, since they do not say how their pieces were supported, can I carry out precisely "Duplex's" test with a piece of copper wire. However, a ½ in. length of 12-gauge copper held by the middle in 20-gauge iron wire melted in 16 sec.

I also have a smaller burner of similar design with a flame tube of ½ in. bore, but this is less successful, because I have not been able to make or find a sufficiently small jet. In consequence, the flame is liable to float away into the air if the gas is turned full on. Nor have I succeeded so far in making Calor gas burners for compressed air, and I hope somebody will tell us something of the principles of burners of this type.

Yours faithfully,
Ambleside. H. C. GILSON.

Camera Design

DEAR SIR,—I have followed Mr. R. F. Stock's article with much interest. He concludes with: "finally, the more ambitious may be interested in Fig. 35. . . . ."

Couldn't Mr. Stock be persuaded to give us (the more ambitious) a complete and detailed design giving a range of speeds from, say, 1/10th sec. to 1/500th sec. and time.

Judging from the correspondence on the subject which has appeared frequently in THE MODEL ENGINEER, a further article on the lines suggested would be welcomed by a large number of your readers.

Yours faithfully,
Falkirk. L. M. HAMILTON.

Small Tool Making

DEAR SIR,—In THE MODEL ENGINEER, No. 2649, S. W. Hugo states D-bits should be turned clockwise on entering and withdrawing from hole, this is surely an impossibility. Having used them regularly for 13 years I find it best to withdraw the D-bit *after* stopping the machine, otherwise the hole will usually be tool-marked on withdrawing. One more point, if only 0.001 to 0.002 is left for removal, the D-bit is liable to follow the drilled hole. However, if 0.008 to 0.010 is removed, the D-bit will cut concentric with the o.d., the main advantage of a D-bit.

May I thank you for editing such an interesting journal, not forgetting all those interested in our hobby who's articles make it the success it is.

Yours sincerely,
Welling. W. V. CORNE.

Carburettors

DEAR SIR,—In the March 6th issue, you published details of a carburettor in which the petrol is variable with the throttle setting.

I have been using one almost the same for the past few months, on a 38 c.c. engine which I have made for my cycle, and find it extremely satisfactory, and would like to point out that a choke is quite unnecessary, as, by opening the throttle beyond its maximum, more petrol and less air is induced, and very easy starting is thereby effected.

Yours sincerely,
Eccles. M. E. SUMMERSIDE.